Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY McGRAW PUBLISHING COMPANY, INC.

Volume 72 NEW YORK, SATURDAY, JULY 10, 1915 Number 2

Tunkhannock Viaduct

IT MUST be with much satisfaction that the engineers of the Lackawanna Railroad witness the last steps in the construction of the great Tunkhannock Viaduct on the Clark's Summit cut-off, just above Scranton. When epoch-making structures of this sort are proposed the engineer, figuratively, doffs his hat to those with the courage to project them, but thereafter, accustomed as he is to handling new problems, quickly loses appreciation of the courage and ability which these structures typify. Nevertheless, the difficulties in a monumental work such as the Tunkhannock Viaduct, the Quebec Bridge, or the Hell Gate Arch are not by any means over when the decision is made to adopt the general design. New problems, never occurring in the smaller structures, constantly come up for solution, and the ability and courage which brought the first design into being must be matched throughout the work in order to handle properly the innumerable details upon which the success of the whole is dependent. Such has been the case in connection with the Tunkhannock structure, and a word of appreciation as it draws to a close is, therefore, in order. The chief engineer, G. J. Ray, his assistants in the drawing room and in the field, and, finally, the contractors deserve to be congratulated on the successful outcome of their work.

Funds for Road Maintenance

THE RECENT legislation in Pennsylvania calling for the registration and taxation of tractors and trailers, as noted elsewhere in these columns, is but one manifestation of an appreciation on the part of the State Highway Department of the importance of maintaining the roads which the Commonwealth has been building. A more recent index of the importance with which the maintenance problem is regarded is furnished by the department's apportionment of State-aid funds among the counties for the years 1915 and 1916, the results of which have just been announced. The feature of this distribution of money is that a definite sum is allotted to each county expressly for maintenance work. In accordance with the policy formulated by Commissioner Cunningham and Chief Engineer Uhler, the maintenance division of the department has estimated the amount of money necessary for the maintenance for two years of previously constructed State-aid highways in each county and this amount has been deducted from the sum available for State-aid construction. This policy is by far the most economical in the long run. In some States the funds are so managed that the necessary amounts are reserved for maintenance, but by making the county allotment known and deducting it from the total of the county's share of State-aid funds, the importance of maintenance is very strongly impressed on the local authorities.

Alloy Steel for Long Spans

TWO DEFINITE features distinguished the design and specifications for the new bridge over the Ohio River at Metropolis, Ill., on the Paducah & Illinois Railroad. The main trusses, as described on page 53 of this issue, are to be built of silicon-steel compression members and nickel-steel eyebars and to provide for Cooper's E90 loading. Although the new 1500-ft. continuous trusses of the Sciotoville Bridge, described in the issue of June 26, page 799, are to be of carbon steel, because it was found that at present prices a nickel-steel design cost about the same, the use of alloy steel for long-span trusses under heavy loading, especially for the suspended trusses of cantilever bridges, as in the Quebec Bridge, generally results in economy. This will be the first example of the application of high-silicon steel to bridge construction, and its action in withstanding shop manipulation and the ultimate cost of production will be watched with interest. The 668-ft. simple truss span of the Municipal Bridge at St. Louis, which now holds the record for span length, was built of nickel steel but it is understood that no saving over the carbon-steel design was realized. The tendency toward large increase in specified live loading which characterizes the design of recent bridges is notable. President Gibbs, in his address before the American Society for Testing Materials, upon his retirement at the recent annual meeting, emphasized the fact that economy in railroad operation pointed toward continual increase in engine power and weight. He could see no limit to the concentrations which rails and structures must be designed to support. When it is remembered that nearly all bridges which were built 20 to 25 years ago have either had to be replaced or reinforced to carry present loadings, the wisdom of the designers of expensive long-span bridges in providing for very heavy live loading is apparent.

Promoting Engineering Work

OBJECTION was made early this year to the free engineering service being offered to small communities by the extension divisions of State universities. The topic was the central one at the meetings of both the Iowa and the Minnesota societies of engineers. The Engineering Record believes that there was good ground for the objection, for if the practice is allowed to grow the field of the consulting engineer, and consequently the incentive for acquiring competence and experience, will be curtailed. This would be a serious blow to the profession and would, in the end, be detrimental to the interests of owners and builders of engineering works. The Extension Division of the University of Wisconsin has appreciated very clearly the danger of usurping the functions of the consulting engineer. It has, therefore, shaped its advisory work, planned for the benefit of the smaller communities of the State, so that in every respect it may be free from the criticism voiced at the Iowa and Minnesota meetings last January. Just how the Wisconsin department proceeds is told in an article on page 47 of this issue. Without a doubt there is a broad field for an activity of this sort, and, when conducted in the sensible way obtaining in Wisconsin, it is a benefit not only to the smaller communities but to all connected with or dependent upon engineering work. For one feature the Wisconsin department deserves special commendation. It has been appreciated that one of the critical difficulties is to advise the community when it puts the question, "Whom shall we employ as engineer?" It is at this point that the advisory department is most likely to get into difficulties and antagonize those whose support and co-operation it needs. Mr. Bascom's solution is to give the town authorities the names of the waterworks superintendents in the State, in order that they may ask for the names and some particulars about the services of engineers employed by these plants. In this way the extension division could not be accused of favoritism. The authorities at Madison are to be congratulated on their skillful handling of a service beset with difficulties.

Popularizing Our Geology

THE U. S. Geological Survey has just embarked upon a very noteworthy departure in its work and one that deserves hearty commendation. Realizing the stimulus given to travel in this country by reason of the locking of European doors and the expositions on the Pacific Coast, it has prepared a series of four guidebooks, covering four of the older railroad routes between the Mississippi and the Coast. Part A will be devoted to a description of the Northern Pacific route, with a side trip to Yellowstone Park; Part B, to the Overland route, with a side trip to Yellowstone; Part C, to the Santa Fe route, with a side trip to the Grand Canyon of the Colorado, and Part D, to the Shasta route and Coast line. The second of the series, Part B, has just been issued as Bulletin 612 of the Geological Survey. As explained in the preface of the first volumes to appear, the books are educational in purpose, but the method adopted is to entertain the traveler by making more interesting what he sees from the car window. The plan is to present authoritative data regarding the country traversed, to explain the geologic features in language readily understood by the layman and to point out the economic features of the various sections along the line. A careful perusal of one of these books while passing from the Mississippi Valley to the Pacific will give one a most excellent comprehension of the economic future of the country traversed, something that the average traveler never gets. To him a trip to the Coast means, at its end, only a jumble of impressive scenery and big deserts, with here and there some unusual feature, generally scenic, standing out from the mass and making a permanent impression on his memory. Those with a serious interest need now not be uninformed as to the features and opportunities of the country they will traverse on the way to the Coast. The first volume, Bulletin 612, is a 244-page book, of 6 x 9-in. page, containing twenty-five 7 x 8-in. topographic maps, each showing a small section along the railroad line, to a scale of 8 in. to the mile and with 200-ft. contour intervals. The text is further illustrated by wood cuts and numerous halftone illustrations of scenic features along the way. The volume should prove very popular indeed with those contemplating a coast trip this year.

Importance of Biological Studies of Stream Pollution

THE ETERNAL cycle of change of matter from the mineral to the vegetable kingdom, from vegetable to animal and from animal back to mineral again is of never ending interest. From time to time one phase after another has been taken up and studied by scientists. Agriculturalists have studied the changes in the nitrogen in the soil from manure to nitrates and from nitrates to the growing crops. Sewage disposal experts have long been familiar with the four conditions of nitrogen —which, in the language of the water analyst, are termed albuminoid ammonia, free ammonia, nitrites and nitrates. Bacteriologists have given attention to the bacteria which help to bring about these changes. At intervals biologists interested in the higher forms of microscopic life have studied the inter-relations of the different forms one to the other. Most of the studies have been fragmentary and have not been pursued far enough to yield practical results.

In his study of the biology of the Genesee River at Rochester, Prof. George C. Whipple, of Harvard, showed the existence of biological zones corresponding to different states of pollution and self-purification. Immediately below the sewer outfalls was found a zone where bacteria were enormously abundant. Next came a zone of protozoa, then rotifers and crustacea, then fish. Each kind of organism thrived upon the preceding, until finally the fish were caught and taken to Rochester to serve as food for human beings, thus completing the chain. This phenomenon is not unique, but universal. It remains, however, to pursue this study in a more detailed and quantitative manner and on a more extended scale. This problem is being taken up in several places, and it bids fair to occupy a prominent place in the thoughts of sanitary engineers for some years to come. Of particular interest are the studies being made at Brockton, Mass., by the biological research department of the Massachusetts Institute of Technology, in the small stream which receives the effluent from the sewage disposal works. Prof. Robert Spurr Weston is in charge of this work. Important researches have also been made by Dr. Forbes and his co-workers in the waters of the Illinois River.

At first thought one would suppose that the pollution of streams by trade wastes would be essentially a problem for the chemist, but the effect of the addition of trade wastes to streams upon the animals and plants in the water and on the shores is often very pronounced. Sometimes their growth is stimulated; sometimes the organisms are killed outright.

The opportunities for similar studies elsewhere are very great and it is hoped that not only trained sanitarians but amateur microscopists will take advantage of the coming summer season to engage in this fascinating and very important field of biology. To be of greatest use the studies should include not only microscopical examination but bacteriological and chemical tests, and the organisms growing upon the shores should be studied as well as those in the water. Only by such extensive and intensive studies will the problem of the self-purification of streams ever be solved.

Dirigible versus Aeroplane

FROM the standpoint of the engineer the performance of aerial craft in the present war is most interesting, especially in view of the widely heralded destructive powers of the Zeppelin, which was, in popular imagination, "a dreadnought of the air," spreading unimaginable destruction along its path. In particular it has been promised for a good many months past that London was to be reduced to a flaming wreck by a fleet of Zeppelins sweeping resistlessly across from the German coast. A considerable number of the illustrated papers have indulged in pictorial forecasts of the impending catastrophe.

The raid on London was made in May, and the first report of it, other than the brief and elaborately censored dispatches, is now at hand. As nearly as can be determined it proved as futile as the previous incursions upon the British coast which furnished practice in bombarding fishermen's huts and sea-shore boarding houses. It is not yet clearly known whether the raid was by one Zeppelin or several. Reports state, however, that about ninety bombs were dropped, in part explosive, but generally incendiary, with the net result of killing outright four persons and injuring about seventy others, a few of them dangerously. A large percentage of the bombs fell on unoccupied land or in vacant streets. Something like a dozen fires were started, of which only a very few required the services of the fire department, and that is about the complete record aside from a very moderate degree of damage to buildings from explosion. The raider was flying high and in the very early morning; its crew was unable to see well the features of the city below, and nearly all of the bombs dropped in the suburbs or poorer quarters of the city.

It is, on the whole, a rather surprising record, after the promises of wholesale destruction that had been made. A few days later another Zeppelin, returning from a raid on the English Coast, was destroyed in Belgium by a bomb thrown from a British monoplane, and if any really keen watch had been kept in the London territory it is more likely that the hostile Zeppelin would have shared a similar fate before she could have flown out of the country.

The truth seems to be that, splendid as the Zeppelin is for long scouting expeditions, it is quite too good a target to risk flying low or in broad daylight, and at night, flying over a darkened city, the chances for effective bomb throwing are greatly diminished. So far as the contest has now gone the honors are decidedly with the aeroplanes as weapons of offence. Their small size, great speed, and extreme facility in maneuvering, make them vastly more dangerous than the dirigibles, particularly when one realizes that dozens of them can be sent out for the cost of a single Zeppelin. The big dirigible is a wonderful feat of engineering and immensely spectacular, but it seems to bear about the same relation to waging war that the huge 25-knot liner does to the world's work of cargo carrying.

Pennsylvania Law for the Taxation of Tractors and Trailers

THOUGH vigorously opposed, a law taxing tractors and trailers was passed by the last Pennsylvania Legislature and has been signed by the Governor. While the taxation of pleasure vehicles and motor trucks is now generally accepted without opposition, traction engines and trailers have heretofore been free in most States. However, the principle being established, it was inevitable that sooner or later they would be brought in under the same general ruling. Probably there will for years be dispute as to the proper amount of tax, which, theoretically, should be based on the relative destructiveness of various vehicles. The manufacturers of heavy vehicles contend that because of the wider tires and the lower speeds the destructiveness of the heavier vehicles is not as great as that of the fast-moving pleasure cars. There is much force to their argument, though, of course, with pavement of deficient thickness, the reverse would hold. The Pennsylvania law attacks the problem from various standpoints and its details will therefore be of interest to highway engineers.

For the purposes of regulation the new measure divides the heavy vehicles into two general classes—those used exclusively for agricultural purposes, road-grading, and the transportation of the machinery which, when at rest, they operate with their own power, and those used for freighting. The registration fees in the first class are $5 and in the second class $20 annually. For trailers weighing less than 10,000 lb., including load, the charge is $3 per year, and for trailer weights in excess of 10,000 lb., but under no circumstances more than 24,000 lb., the fee is $5.

Limiting weights also are prescribed for tractors of both classes—for the first class, 28,000 lb. and for the second, or freight-hauling traffic type, 32,000 lb. Cleats are allowed on the drivers of all traction engines, but their width must be at least 2½ in. and their height not more than 1½ in. In the case of the trailers the tires must be smooth and no load exceeding 750 lb. per inch width of tire is allowed.

These are, in brief, the main provisions of the law in so far as it relates to weights, widths of wheels and type of cleats. But as a further safeguard to the highway system the State highway commissioner is vested with authority to designate allowable hauling routes. Applications, setting forth the roads to be used and the weights of the tractors, must be made in advance, and the commissioner may use his discretion as to the granting of permits. This is an important point, for, even if a tractor fulfilled all of the requirements previously outlined, its owner might elect to operate it at a time when the roads were soft. As a result there would be serious damage to the surfacing. With the powers granted to him, however, the commissioner may allow heavy vehicles to operate only when the routes are in a condition to carry heavy loads.

There is but little doubt that taxes and restrictions of these general types are to be expected in other states in the near future. The tendency is to make those pay who most directly benefit by an improvement and to apply reasonable safeguards for the protection of the surfacing. Opposition there will be, but the energy had better be expended on keeping the restrictions and taxes reasonable than in opposing the principle in toto.

Common Sense Regarding Academic Freedom

JUST at present comment is rife in Philadelphia and among graduates of the University of Pennsylvania over the refusal of the trustees of that institution to renew a contract with a member of the economics faculty. It is stated by those agitating for his re-employment that his virtual dismissal is due to the disagreement of the trustees with certain economic opinions advocated by him. They declare that "academic freedom," the right of members of the faculty to pursue unhampered their investigations and publish their results, has been curtailed. This journal is not informed as to the facts in the Pennsylvania case, but because of its importance the Engineering Record takes advantage of the opportunity afforded by the incident to discuss the general subject of academic freedom. Its abuse is such that every educated man needs to do some vigorous thinking on the subject.

It is contended in the university world that the university cannot fulfill its functions as the leader of thought unless members of the faculty are free to pursue their investigations wherever they may lead and to publish without restraint or supervision their conclusions. With this contention, in the abstract, this journal has no quarrel. It does believe, however, that the doctrine of academic freedom has been pushed to absurd conclusions.

This journal cannot believe that the wide and unqualified endorsement by educated men of the doctrine of unhampered academic liberty has been given after full consideration of all that the doctrine involves. American men, in the mass, especially educated Americans, think sanely. They discover quickly theories that lead to absurd results and are not slow in expressing their opinions.

To hold that there should be no restrictions on academic freedom is to concede that, no matter how false the theory or how destructive its conclusions, every immature instructor or radical professor shall have the privilege of teaching it to American young men and women at the most impressionable period of their lives. The man who advocates unhampered freedom of speech in university circles would protest most loudly if a member of the faculty were allowed to teach immoral doctrine, immoral in the sense in which we usually use that term. Yet, broadly speaking, it is just as immoral, just as much a violation of the fundamentals of ethics, to teach, for example, under the guise of a new economic theory, that race suicide is justifiable or that theft is legitimate. The latter doctrine certainly has been taught in at least one of our institutions, for a teacher in the economics faculty advocated the right of the Government to take private property without compensation. Socialism is another of the vagaries, taught not with a view to examining into its principles, as one would into any other economic doctrine, but advocated and preached from the professional chair. Fathers of youths now in American universities can multiply with ease the list of false doctrines to which their sons and daughters are obliged to listen.

Unquestionably we must permit freedom in investigation and research. For the sake of the ultimate good we must bear with half-baked theories, silly doctrines and perverted conclusions, but that does not necessarily imply that these same theories and conclusions are to be taken into the classrooms and to be taught as true to those not yet mature enough or sufficiently familiar with the subject to discover the error. The place for those theories and conclusions is the forum afforded by the meetings and journals of the learned societies, where they come for examination before a body of specialists. Unfortunately, however, this is just what these immature minds do not want. While professing to seek the truth they are in reality seeking the truth as they want it to be, and the last thing they care to do is to put their theories before those fully competent to analyze them.

Necessarily, if academic liberty is to be restricted, there must be some body or authority which shall set the limitations. For this we must look to boards of trustees and heads of departments. When, however, they exercise their proper functions —when they stand between our young men and women and a faculty member who is teaching error—the local press, members of the faculty and graduates immediately go up in arms over the restriction of "free speech." An instructor, so limited by higher authority, immediately becomes the recipient of the martyr's crown, his popularity increases many fold over night and protests deluge the trustees or whatever authority has taken the action. It is a sad commentary upon the quality of our education that so many university graduates should be found in this unreasoning throng.

As a result of experiences of this kind, boards of trustees have learned how difficult it is to handle such cases of needed discipline, and, without a doubt, have been deterred in many cases from taking what they believed to be desirable action. Methods of quiet elimination have undoubtedly been tried rather than face the storm of protest sure to be aroused if "straight-from-the-shoulder" action were taken. Radical and immature members of the faculty appreciate this, too, and therefore do not hesitate to abuse the privilege of academic freedom, confident that in case of discipline the masses will be with them.

It need hardly be added that a faculty member taking advantage of his board of trustees or his department head in this way can only be described by the word despicable. If he could stand alone, isolating himself from his university, but little harm would be done. But the press takes delight in calling the merest tyro on the faculty "professor" and in linking his name with the institution, so that his doctrines, no matter how radical or erroneous, go forth with the weight of university authority back of them. The instructor or professor cannot speak in his private capacity, even if he would. When, therefore, in defiance of what he knows to be the attitude of his superiors, he insists upon giving vent to his unsound doctrines, he acts as a mountebank, forcing his own personal views upon an unsuspecting public under the guise of university backing.

Considering these points, therefore, the Engineering Record cannot believe that the championship of unhampered academic liberty by university men has been the result of mature thought. Free speech may consistently be advocated without holding that faculty members should be allowed to impose their doctrines on unsuspecting and immature youths. If parents have a duty to protect their sons and daughters from immoral influences, that duty is just as binding with reference to economic and other fallacies as with reference to those we generally describe by the word immoral. And the duty imposed on the parent is necessarily transferred to the boards of trustees and other authorities, to whom the education of his children is entrusted.

Why Drainage of Irrigated Lands Is Necessary, and How the Problem Is Handled

Leakage from Canals and Excessive Use of Water for Crops Cause Saturation of Subsoil and Depositing of Alkali on Ground Surface—Remedy Lies in Intercepting and Relief Drains

By D. W. MURPHY
Engineer in Charge of Drainage, U. S. Reclamation Service, Los Angeles

A QUESTION frequently asked, especially by those not fully acquainted with farming operations in the arid regions, is why there should be a requirement for drainage on lands to which water is supplied by irrigation. Why, if water is supplied artificially to the lands, should more be applied than is necessary to keep the soil in a condition for growing crops; or, in other words, why should there be any excess waters in the soil to be drained out? It must be admitted that if no more water reached the land than that which could be taken up and used by growing crops no excess would be found in the soils, and no drainage would be necessary. This condition is the ultimate goal of perfection in irrigation practice. It cannot be regarded as impossible of being attained, but can be reached only after long experience in the construction and painstaking care in the operation and use of irrigation works. It is apparent to the careful observer that the need of drainage during the past ten years or more has been increasing rather than decreasing—and this despite the better methods of irrigation that are constantly being adopted.

In order to get a clear understanding of why drainage is required on irrigated lands it is necessary to consider the various phases of irrigation, from the taking of water from the source of supply to its application to the soil. To explain the increasing need of drainage it is necessary also to consider the development of irrigation and its effect upon ground-water conditions over largely increased irrigated areas.

WHERE IRRIGATION WATER GOES

During the past ten years the growth of irrigation, over the greater part of the arid regions, has been rapid. New enterprises have been developed on large and comprehensive plans, and the older ones have been enlarged and extended so as to reach more nearly the limits of available lands and water supply. The conserving of all streams, or the greater part of them, by means of storage works, and the supplying of extensive canal systems have made possible the irrigation of large individual areas. Valleys or plains miles in extent have been covered by networks of canals, into which water has been turned. From these canals water has been diverted to the surface of the ground in varying amounts, depending on the smoothness of the surface, the character of the soil and the individual ideas of the irrigator applying it.

A part of the water carried by the canals and laterals is lost by seepage from them before it reaches the irrigator. A part of that delivered to him is wasted from the surface and absorbed by adjacent areas where possibly it is not needed; a part is lost underground because more is applied to the surface soils than they can retain and use in the growing of crops. The result is, water is supplied not only to the surface soils, but a part is lost into the subsoils, which gradually become filled if the underground losses are not removed. A large part of the water lost in the subsoils is carried away through natural channels through the slow process of underground percolation. In many instances, especially on areas of limited extent, and where the subsoils are of a uniform, porous nature, the natural underground drainage is sufficient to carry away the excess water and prevent the subsoils becoming saturated. But on large areas, or even on small ones, where the underlying materials are more or less impervious and irregular, natural drainage is generally not sufficient to carry away the underground losses. In such cases the subsoils become filled, and the ground water is raised in many cases to the surface of the ground.

CONSTRUCTION TO PREVENT LEAKS FROM CANALS EXPENSIVE

The principal sources of ground water on irrigated lands, as above stated, are losses from canals and laterals, and underground waste due to excess application to the land. Losses from canals and laterals can be avoided only by lining the waterway or constructing the canals of watertight materials such as concrete or other forms of masonry. The cost of such work is high, and in many irrigated sections is regarded as prohibitive on this account. Losses due to excess irrigation are largely the result of applying to the soils at a single irrigation more water than they can retain and give up to the growing plants. The excess sinks into the subsoils and contributes to the raising of the ground-water table.

As is well known, the amount of water necessary to render the soil moist to the depth required for plant growth varies with the character and fineness of the soil, and also the character of crop being grown. The amount or depth of water that should be applied at one irrigation, under varying conditions of soil and crop, is difficult to determine. Even though this be definitely known, the uniform application of the required amount and no more over the land presents in many cases even greater difficulty. Some soils, especially before they have been thoroughly broken up by cultivation and growth of plant roots, absorb water slowly, and it must be held on them for a relatively long period of time to allow it to penetrate to the required depth. Other soils, such as porous sands and gravels, absorb water so rapidly that it is difficult to carry it for even a few hundred feet over them without excessive underground wastes. Economic irrigation, or the application of just the right quantity of water to the soils, requires careful preparation of lands and care and skill on the part of the irrigator.

MORE WATER USED THAN NECESSARY IN IRRIGATION

Observations of the effects of varying quantities of water applied to growing crops, and also measurements of the underground losses, both show that ordinarily more water than is necessary is used in irrigation. The result of this is the filling of the subsoils and the raising of the ground-water table.

Another contributing factor to ground waters, although far less frequent than those above mentioned, are underground percolations from natural streams or from precipitation on higher areas. Even in the semi-arid regions, and where irrigation has not been practised, examples are found where the ground water is but a few feet below the surface. In such cases the ground waters have generally traveled down slopes, possibly some distance below the surface, and have been stopped by a more or less impervious formation at or near the foot of the slopes. High ground-water areas are also found frequently in porous beds of sand or gravel which are overlaid and possibly surrounded by dikes of clay or other impervious materials.

Whenever the underground losses on a given area due to seepage from canals and streams and waste from excess irrigation are greater than the natural drainage from that area can carry away, the subsoils gradually become filled and the ground-water table rises. Examples of this kind have

SUBSURFACE CONDITIONS DETERMINED BY USE OF ORDINARY SOIL AUGER been found where the water table has risen from 50 to 100 ft. within a period of ten years or less. On large irrigated areas the ground waters must ordinarily travel greater distances than on small ones. There is consequently greater danger of the subsoils becoming filled and the water table being brought to the surface on them.

EFFECTS OF HIGH WATER TABLE

The effects of a high water table are first, to render the soil unfit for growing crops on account of its interstices being filled with water, or, as it is generally termed, becoming saturated; and, second, to cause a deposit of alkali upon the surface, the result of capillary action and evaporation. In order that plants may survive and produce proper growth in a soil, it must be moist, but not saturated. To accomplish this, the water table must be kept below the zone of plant growth.

In most sections of the arid or semi-arid regions the soils contain more or less alkali salts, many of which when sufficiently concentrated are harmful to plant growth. These salts, which are soluble, are dissolved by the ground waters, and when the water table is high enough to permit the water being brought up and evaporated, the salts are left on the surface, as the result of such action. This in a short time causes a sufficient concentration of salts on the surface to render the lands unfit for cultivation and the growing of crops. In order to prevent the concentration of salts near the surface it is essential that the water table be kept low enough to prevent capillary action bringing excess quantities of ground water to the surface.

PURPOSE OF DRAINAGE

The fundamental purpose of drainage works is to control the ground-water table and prevent its rising high enough to impair the irrigability of the soil, either through saturation or through the accumulation of alkali. Ground waters are not stationary, but are slowly moving through the minute spaces of the subsoils from lower to higher areas. In this movement they are affected by the character of the subsoil formation. Where this formation is uniform as to porosity and thickness, ground waters may travel at a relatively uniform rate and distance below the surface. Where the porous subsoils are broken by dikes or barriers of less pervious materials, the underground flow or percolation is retarded and the waters are forced to the surface. As a result of this condition the rise of ground waters is seldom, if ever, uniform over any considerable area.

Ordinarily seepage, or the rise of ground water to the surface, begins at isolated points. These may be either along or at the foot of slopes, or even on a level area if it be underlaid by a pervious bed of sand or gravel. In the latter case the seepage first appears where the top soils are thinnest or where they offer the least resistance to the upward movement of the water. From the points of starting seepage gradually spreads, the direction and rate of spreading being dependent on the amount of flow and resistance offered by the top soils to water penetrating them.

DITCH LOCATED TO SKIM OFF TOP LAYER OF WATER IN WATERLOGGED SOIL

Drainage works must be so located and constructed that they will be effective in skimming off or disposing of the top portion of the ground waters over those areas where there is a tendency for them to reach the surface. These high water areas may be relieved in some cases by intercepting and carrying away the flow at the foot of the slopes, or at points where water is forced to the surface by the presence of impervious barriers. In some cases it is necessary to tap large reservoirs of porous sands or gravel, and by drawing the water out of these, effect a general lowering of the water table over the entire adjacent area.

TWO CLASSES OF DRAINS

The conditions above mentioned have given rise in drainage work to two quite distinct classes of drains, known as intercepting drains and relief drains. The first class applies to drains by means of which water is intercepted and carried away before it reaches lower areas which might be injured by it. The second class applies to those which tap, as it were, underground reservoirs in porous materials and effect a general lowering of the water table over them.

It is sometimes impossible to dispose of water by means of intercepting drains constructed along or at the foot of slopes, on account of the great depth to the pervious material through which it is traveling. It is also frequently difficult to remove ground waters from relatively flat areas by means of drains constructed in them. The porous materials through which the waters actually come to these areas may be found at depths so great as to make it impracticable to tap them by means of drains. In such cases the water in the lower subsoils is usually found to exist under pressure which in time is sufficient to force it through the heavy layer or blanket of top soil to the surface. Relief to such areas can frequently be given by means of wells sunk from the bottom of drains into the porous water-bearing materials.

To determine the location, type and depth of drains to be used are questions to which no general answer can be given. They depend on local conditions in each particular case and can be determined only after careful investigations and study of the character of the subsoils and the ground-water movement through them.

LOCATION AND DEPTH OF DRAIN

To be effective drains must first of all be located so that they will tap the underground water in porous materials in order to produce a flow into them. They should also carry the water so collected to some natural waterway without allowing it to be lost in the subsoils and become a source of waterlogging on other lands. The depth of drains must be sufficient to lower and hold the water table below the zone of plant growth, and also below the depth of excessive capillary action to the surface. Both of these vary largely. The depth to which the roots of ordinary field crops penetrate the soil ranges roughly from a few inches to about 4 ft. This maximum is, however, in many cases greatly exceeded. The minimum depth to water for crop requirements, consequently, depends largely on the nature of the crop, whether deep or shallow rooted. In determining the depths of drains, consideration should be given to the protection of the deepest rooted plants to be grown.

The height that water will be raised by capillary action varies greatly with the texture and condition of the soil. It ordinarily ranges from about 18 in. to 3½ ft. for any appreciable quantity of water being brought to the surface. In some instances a perceptible capillary action has been observed to a height of 7 ft. This is exceptional, however, and it is believed that the quantity of water ordinarily raised more than about 3½ ft. is too small to impair the lands seriously by the bringing up of alkali. The condition of the surface of a soil is an important factor in determining the amount of water which rises to and is evaporated from it. A well mulched surface reduces capillary action and consequent evaporation.

The depth to which drains must be constructed frequently depends on the depth to various water-bearing materials. In many cases it is necessary to go to greater depths than soil or crop conditions would require in order to reach materials sufficiently porous to allow water to pass readily through them. The determination of proper locations and depth of drains requires a knowledge of the surface topography, elevation and slope of the ground-water table and the water-bearing properties of the subsoils through which these waters must pass.

INVESTIGATIONS AND SURVEYS

One of the important factors in the location and planning of drainage works is the collecting and putting in convenient form for use the necessary information relative to ground-water and subsoil conditions. Surface topography necessary for determining the slopes available and the location of main outlets can be readily determined by means of surveys, or in many cases from existing contour maps. Data relative to underground conditions are more difficult to obtain, and the most thorough investigations that can be made reveal only partly the conditions governing the movements of ground waters.

Instances are sometimes found where the subsoils are uniform in character, and where the ground water in them maintains relatively uniform slopes. These conditions can be determined by means of relatively few borings or test pits. Generally, however, the subsoils lack uniformity both as to character and thickness and the slopes and direction of percolation in them are very erratic. Conditions of this sort require the collection of a large amount of field data and a systematic arrangement of these data in order to give the necessary information for laying out a drainage system. Miscellaneous data relating to depths, to ground water and to character of underlying materials are of little value in showing the source of ground-water supply, or where it can best be reached by means of drains.

PLAN DEVISED FOR DETERMINING UNDERGROUND CONDITIONS

The most satisfactory plan so far devised by the writer for determining the underground conditions is by means of subsurface cross-sections or profiles. The sections are usually taken at, or nearly at, right angles to the natural slope of the country. They are prepared by first running accurate surface profiles by means of chain and level or other suitable means. These are platted on a scale of from 500 to 1000 ft. to the inch horizontal and 10 ft. to the inch vertical. This large vertical scale permits showing the details as to character of subsoils and elevation of water table. The small horizontal scale is convenient for showing in a compact form the conditions over a large area.

The elevations of ground water and the character of the underlying materials are indicated on the sections by means of convenient symbols. Wherever possible the sections are taken on parallel lines and are platted one above the other from the lower to the upper part of the area. All are referred to the same straight line so that the location of any point on a section can be readily determined on the ground. When the sections can be taken on east-and-west or north-and-south lines, as is usually the case, they are referred to rectangular coordinates. Distances are usually given in miles and fractions of a mile. Such a series of sections when platted represent a sort of relief map of the area covered by them.

The elevation of water table and the character of the underlying materials are determined by means of borings or test pits. The latter are used in heavy gravels or other materials through which the auger cannot be made to penetrate. For making borings an ordinary hand soil auger about 2 in. in diameter is commonly used. With this form of auger borings have been made and the materials determined to depths of 30 ft. or more. Where borings are made in sand or silty materials which cave readily the wells are kept open by means of light iron casings. This is generally necessary, also, where a series of readings is to be taken for the purpose of determining the elevation of the water table.

The interval at which sections are taken depends on the surface topography, the nature of the subsoil formation and the variations in elevation of ground water. It usually ranges roughly from ½ mile as a maximum to about 200 ft. as a minimum. Similarly, the distances between borings or test pits in a section are made to suit each particular case. They must be near enough to each other to give a reasonably accurate profile of the top of the ground water and also to show variations in the underground formation. The depths to porous strata and the pinching out of these strata are factors which must be carefully determined. These in some instances require borings at intervals of 50 ft. or less.

USE OF SECTIONS IN LOCATING DRAINS

The primary purposes of subsurface sections is to show the grades and direction of flow of ground waters, and the locations of the various classes of materials which affect this flow. They show also the locations of high ground-water areas and where these areas may be tapped to lower the water table over them.

The points at which a drain should cross the various sections gives a preliminary location which can be quickly determined and marked on the ground. The final location is made by connecting these preliminary points by the most feasible lines. Except over very rough areas, and even there if the sections are taken close together, reasonably accurate profiles of any proposed line can be prepared from them and the available slopes determined. The depths to which drains must be constructed in order to reach porous water-bearing materials is shown by the position of such materials on the subsurface sections.

Flat-Slab Bridges at Denver Combine Permanency and Good Appearance

Four Such Structures Built Across Cherry Creek Were Specially Designed to Withstand Such Floods as Wrought Havoc in 1912

By WALTER H. WHEELER
With C. A. P. Turner, Minneapolis

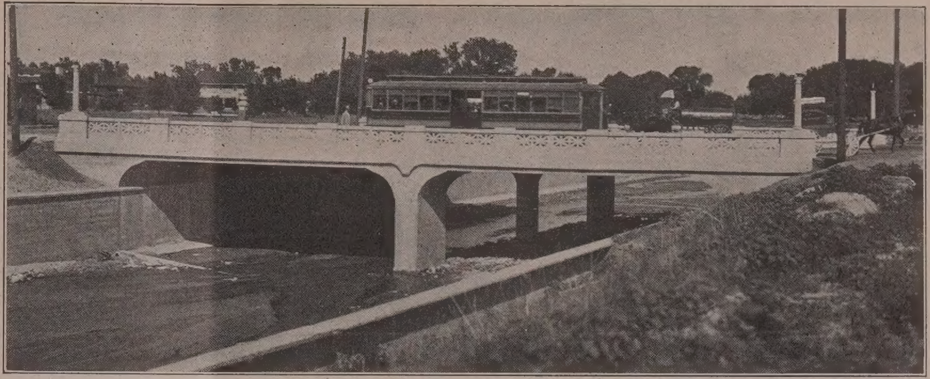
IMMEDIATELY after the disastrous cloudburst and Cherry Creek flood which occurred at Denver July 14, 1912, it became necessary for the city, in connection with the repair work which followed the flood, to consider the construction of four new bridges spanning the channel of the creek. For most of its course through the city the channel is confined by reinforced-concrete retaining walls and varies from 80 to 100 ft. in width, the depth ranging from 10 to 15 ft. The grade of the creek bed is quite steep, causing the water to flow, in times of flood, at a high speed, and there is frequently considerable débris brought down.

To meet these conditions the city desired to construct bridges which would be as nearly permanent as possible and at the same time be ornamental and provide the greatest area of clear waterway for a given elevation of roadway. It was decided to use reinforced-concrete construction and competitive designs and bids were called for on the Market and Larimer Street bridges, situated on opposite sides of the city hall. Designs were submitted for two-span and single-span bridges of the girder, arch and flat-slab types and contract was let for flat-slab bridges of the "mushroom" type. The design gave a clear waterway 10 per cent in excess of the other designs submitted. Later the city let a contract for a bridge at Downing Street and for one at Curtis Street, in both of which the same system was specified.

The new bridges give more clearance underneath than the old steel bridges they replace, and the bottoms of the slabs are smooth and do not offer any opportunity for driftwood to catch in passing under and form a dam, as did the steel bridges.

The Downing Street bridge is 80 ft. wide by 106 ft. long over all. The spans between piers, center to center, are 45 ft. longitudinally by 34 ft. transversely. The roadway is 56 ft., with a double-track street-car line in the middle, and 12-ft. sidewalks at each side of the roadway. This bridge crosses somewhat obliquely, so that the longitudinal lines of pier centers intersect the transverse lines of centers at about 70 deg., making the perpendicular distance between longitudinal lines about 32 ft. For purposes of computation the spans will consequently be taken as 45 ft. and 32 ft. The bridge is designed to carry a working live load of 150 lb. per square foot over the full area and provides for a moving load of one 75-ton car and one 18-ton road roller on each panel, plus ordinary vehicle and foot traffic. The rails of the car tracks are carried on Carnegie 5½-in. steel ties embedded in the concrete of the slab. The roadway is paved with 3½-in. 16-lb. creosoted wood blocks, manufacturers' standard specification, laid on a 1-in. sand cushion. The slab is 20 in. thick at the gutter, 25 in. thick at center of roadway, 31 in. at inside edge of sidewalk, and 32 in. at outside edge of sidewalk. There are three rows of three columns or piers each crossing the stream, a middle column of each row in midstream. The center midstream pier is 36 in. square; the two outside midstream piers are built oblong in section and are 3 ft. wide by 9 ft. 6 in. long, the idea being to bring the piers out flush with the edge of the bridge and give the spans, when viewed from the side, the appearance of a flat arch. The six end piers are 42 in. square.

All piers are carried down to bedrock and anchored thereon with four 1⅜-in. round rods extending 4 ft. into the rock and



DOWNING STREET BRIDGE OVER CHERRY CREEK, DENVER

grouted. Bedrock at Downing Street averaged about 5 ft. below the Creek bed, at Market Street about 15 ft. The bedrock is shale and the footings of the piers are proportioned for a bearing on the rock of about 8 tons per square foot when the bridge is fully loaded. Embedded in each sidewalk 24 in. above the bottom of the slab are 7 lines of 4 x 12-in. hollow tile, spaced 18 in. on centers, for wire conduits. At each end of the bridge a thin wall is carried down flush with the edge of the bridge to the top of the retaining wall to carry out the flat-arch effect.

REINFORCING

The reinforcing in the slab consists of belts of rods running in four directions, between piers, with 16-ft. laps in every belt at each mushroom head. The belts are 16 ft. in width, which is the width of the "mushroom" heads on the piers. These heads are made exceptionally stiff, having twice the usual number of radial and ring rods. The outer edges of the slab are carried as a cantilever and reinforced with supplementary rods running longitudinally near the edges of the slab. There is also supplementary reinforcing in the sidewalk near the surface. The columns or piers are reinforced with vertical rods and spiral hooping. All steel is plain round bars, manufacturers' standard specifications for structural grade.

The wearing surface of the sidewalks is floated smooth and blocked off in squares. The hand railing and lamp posts are of ornamental cast stone manufactured by the National Stone Manufacturing Company of Minneapolis, and are laid up in cement mortar.

The writer is not aware that any tests have been made on the bridge since its completion, but it has been in actual service about two years. The construction work was done during the winter with the thermometer registering as low as 20 deg. below zero at times. Artificial means were employed to prevent the concrete from freezing. The water used in mixing, as also the aggregate, was warmed, and salamanders were kept fired under the slab for a period of about three weeks after casting.

STRESSES

Referring to Dr. Henry T. Eddy's book, recently published, entitled "The Theory of the Flexure and Strength of Rectangular Flat Plates, Applied to Reinforced-Concrete Floor Slabs," and applying his formula, it will be noted that the width of the belts of rods in the slab of the Downing Street Bridge should be such in the mushroom system as to make them cover practically the entire area of the slab, which is found to be the case in this design, although, by reason of the obliquity of the bridge, this width is some 10 in. less than 7 $(L_1 + L_2)/32$, which would have been required in case of rectangular panels for the "mushroom" system, where L_1 equals longitudinal span and L_2 transverse span. Applying his formula and assuming a dead load for the slab of 350 lb. per square foot and a live load of 150 lb. per square foot distributed over the full area of one panel, which equals a total load of 720,000 lb. evenly distributed, we find f_s, the stress on the steel, is about 8300 lb. per square inch, and under a test load of double the working load f_s equals about 10,800 lb. per square inch at the middle of the 45-ft. span.

The number and length of the laps over the columns reduce the unit stresses in the steel over the edge of the caps below that at midspan. Were four times the live load placed upon the bridge, the greatest unit stress in the steel would be only 15,800 lb. The factor of safety may, consequently, be taken as more than 4.

Again applying his formula for the deflection at the center of the panel, we find, under a test load of 300 lb. per square foot evenly distributed over the full area of a panel, the deflection at the center would not exceed 0.18 in., which is less than 1/3000 of the span. But this formula is one derived to compute actual deflections for heavy loads only where the unit stresses in the steel are 20,000 lb. or more, and give results much in excess for small loads. On this account and owing to stiff sidewalks over 30 in. deep, longitudinal car rails, and pavement, it is probable that no deflection could be detected under test load.

Assuming the neutral axis to be at the bottom of the slab at the edge of the pier the maximum stress on the concrete on the center of the slab, computations show that caps is everywhere less than 700 lb. per square inch, the allowable working stress.

From the above it will be seen the stress values for concrete and steel used in designing the slab of this bridge are very conservative. It will also be noted that the formulæ used in obtaining the above values for stress in steel and concrete are applicable only where the stiff column heads of the "mushroom" system are used.

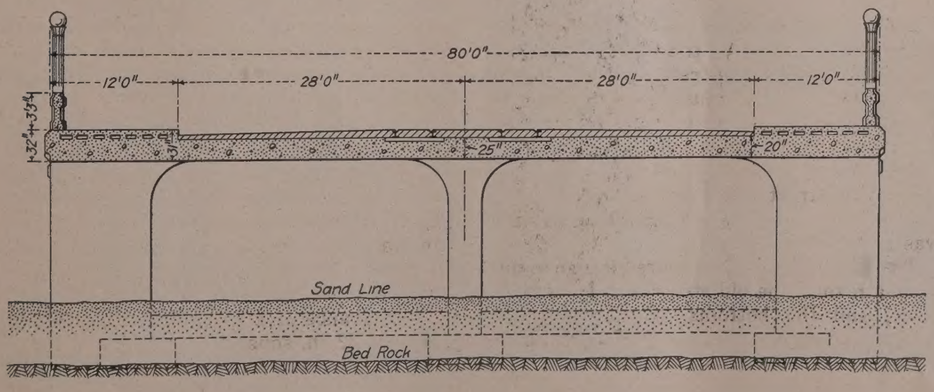
The Downing Street bridge was constructed by the C. P. Allen Contracting Company of Denver. The concrete for all piers was cast up to the sand line before the centering for the slab and the remainder of the piers were erected. The balance of the bridge was cast in one operation, but not continuous, the slab being divided into panels, so that one panel with its piers could be completed in a day's run, all joints in the slab being made at the centers of spans, using temporary wooden bulkheads to secure smooth vertical joints. The concrete was all machine mixed and placed with two-wheeled carts.

CENTERING

The centering for the slabs consisted of 6 x 12-in. posts spaced about 8 ft. 3 in. on centers both ways, carried on 12 x 14-in. mud sills and sway-braced both ways with 3 x 6-in. bracing. Stringers 12 x 12 in., of Oregon pine, were laid directly on the posts, and 2 x 12-in. Oregon pine joists laid over the stringers 12 in. on centers, with 1-in. sheeting over the joists. Very little cutting of the form lumber was necessary because of the flat slab without beams, and the salvage on it to the contractor was therefore exceptionally large.

Mud sills were used instead of piling, as ordinarily Cherry Creek carried very little water in the winter time, and it was expected the work would be completed before the usual spring freshets. The specifications provided that the slab centering should remain in place for not less than sixty days. The work was delayed somewhat in starting, which brought the casting of the slab later in the spring than was expected, and about thirty days after casting an unusually early freshet cut away the sand under the mud sills, allowing the forms to settle several inches. As far as could be observed, however, there was no settlement in the slab. This practical test clearly shows that the concrete when properly cured is far from overstressed, as it is now probably three times as strong in compression as it was thirty days after casting, and should carry five times the full working live load as easily as it then carried its own dead load.

The contract price for the bridge, plus



CROSS-SECTION SHOWING MAIN DIMENSIONS OF ONE OF THE BRIDGES the cost to the city of reinforcing diagrams, steel and artificial stone, was about $17,400. This did not include the track work, which was a separate item and paid for by the Denver City Tramway Company. As the bridge is constructed it is absolutely independent of any end abutments or retaining walls, and approaches and retaining walls could be entirely washed away and the bed of the creek scoured down to bedrock without injury to the bridge. In the event of a flood passing over the top the railing and lamp standards might be injured, but could be easily and comparatively cheaply replaced. The stone railings might wash away if submerged by a flood and leave only the relatively thin slab impeding the flow of the water, which would tend to cause only slight overflow. The weight of the bridge itself adds greatly to its permanency.

The total contract price for the Market Street bridge was $17,150; for Larimer Street bridge $17,850. The contract price of the Curtis Street bridge plus cost to city of reinforcing diagrams, steel and artificial stone was $12,300. On all four bridges the writer acted as engineering agent for C. A. P. Turner of Minneapolis, designing and furnishing the reinforcing steel and artificial stone.

Standard Grades and Cross-Sections for Colorado Roads

MAXIMUM road grades adopted by the Colorado State Highway Commission are 6 per cent, and most of the lines laid out over the Continental Divide are within this limit, with the exception of a few short stretches. The standard width of road is 28 ft. from ditch to ditch, with a rise in the center of the road of 20 in. from the bottom of the ditch. The section was designed, states J. E. Maloney, State highway engineer, with the idea that blade machines and teams could be used to do the crowning. For sidehill work the width from a 2-ft. ditch to the outside of the road is 18 ft. The slope toward the hill is ½ in. per foot. For embankments a width of 24 ft. has been adopted, with a rise of 1½ in. to the foot.

First 2400-Volt Third-Rail Line Is Built

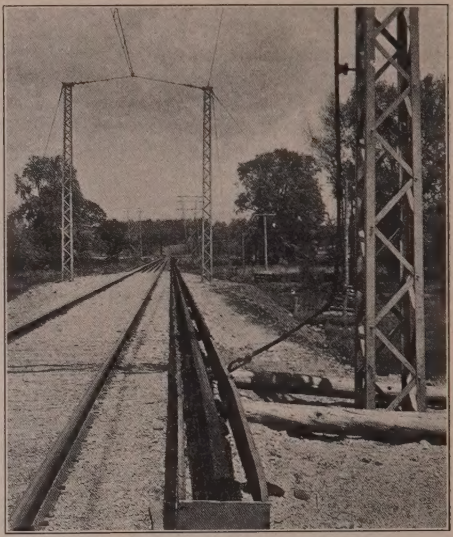
Electric Road in Michigan, Linking Grand Rapids, Kalamazoo and Battle Creek, Is Designed for Heavy Loads and High Speeds

A 2400-VOLT third-rail electric railroad—the first ever built to use such a high voltage with the third rail—has just been completed in Southern Michigan. The line is owned by the Commonwealth Power, Railway & Light Company of Grand Rapids, and has just been turned over to the Michigan Railway, the operating company. It consists of a new line 50 miles long from Kalamazoo to Grand Rapids, and branches to Battle Creek and Allegan, obtained by buying and electrifying a 44½-mile branch of the Michigan Central Railroad connecting these two points. The Battle Creek-Allegan line crosses the new line at Monteith Junction, 18 miles from Kalamazoo and 30 miles from Battle Creek. The Kalamazoo-Grand Rapids section represents the highest type of modern electric-railway construction, being designed for heavy loads and speeds up to 90 miles per hour. Some of the trains are scheduled to run the 50 miles in seventy minutes.

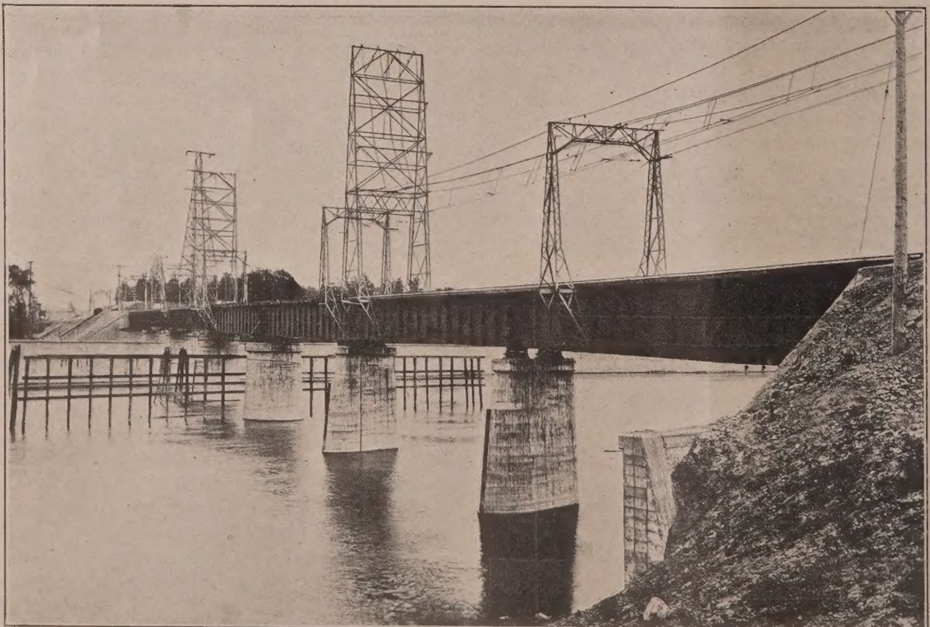
GENERAL FEATURES

The territory traversed between Grand Rapids and Kalamazoo is slightly rolling, some rather heavy cuts and fills being necessary. Except in the city streets of Kalamazoo, and on a section of private right-of-way in Grand Rapids, the maximum curvature is 3 deg. and the maximum grade 1 per cent. The roadbed is 18 ft. wide on fill and 24 ft. wide in cuts, 1½:1 slopes being used in each case. The total amount of grading for the 50 miles was about 1,000,000 cu. yd., the heaviest being 20 ft. deep and 2000 ft. long, and involving 85,000 cu. yd. The maximum fill contained 60,000 cu. yd. and was 30 ft. deep. In general, the right of way is 100 ft. wide. Through Grand Rapids there is a section of private right-of-way several miles long, wide enough for a second track. All right-of-way is fenced.

All waterways and under or over crossings are concrete or concrete and steel combined. For the smaller openings reinforced-concrete pipe was used, furnished under contract by the Chicago Reinforced Concrete Pipe Company. This pipe was made on the right-of-way with a portable concrete mixing plant which was moved along the line to minimize the haul of the completed pipe.



BOARD EACH SIDE PROTECTS THIRD RAIL



LOWER GRAND RIVER BRIDGE AT GRAND RAPIDS HAS DRAW SPAN, NECESSITATING HIGH TOWERS FOR FEEDER-LINE CROSSING

BRIDGES

All bridges and viaducts except those to carry foreign roads were designed for Cooper's E-40 loading, which is approximately equivalent to a 100-ton car. For overhead highway crossings the ordinary three-span type of bridge was generally used.

Two bridges of unusual size were constructed over the Grand River in Grand Rapids. The lower Grand River bridge consists of seven 88-ft. deck girders resting on concrete piers, the two central spans of which rest on a circular pier and are designed as a draw span. Double-track approaches of this bridge from each side close into gauntlet tracks over the bridge. This structure, with its two 59-ft. towers, giving a 210-ft. feeder span, is shown in one of the accompanying illustrations.

The upper Grand River crossing is a double-track reinforced-concrete bridge. The Grand Rapids passenger terminal is at one end of the structure and a freight yard and repair shops are at the other end. The bridge is of the Luten type, with four 96-ft. spans and one slightly longer.

All track, including main track and sidings, is laid with 80-lb. A. S. C. E. rail on 8-ft. cedar ties, twenty to a 33-ft. rail. Every sixth tie is 10 ft. long and furnishes support for the third rail. Main-line turnouts are built with No. 12 frogs, 18-ft. switch points and 90½-ft. leads. Passing sidings are approximately 1000 ft. long, built according to main-line standards, except that the third rail is lighter. All turnouts were finished by the Cleveland Frog & Crossing Company, as were the manganese-steel crossings at all grade intersections with foreign roads. All grade crossings of other railroads are interlocked.

THIRD RAIL

Along the main line the third rail is an 80-lb. A. S. C. E. low-carbon rail rolled especially for this road; on industrial sidings and passing tracks 52-lb. relayer is used instead. The center of the third rail is 32 in. from the nearest gage and the top is 8 15/32 in. above the surface of the track rail. The type of protection is shown clearly in one of the photographs.

In the cities and elsewhere where the overhead trolley replaces the third rail, three types of catenary suspension have been used. Where there are two tracks they are spanned at 300-ft. intervals by double-track special galvanized-steel bridges with the legs set in concrete. The legs are 32 ft. 1 in. long and set 5 ft. in concrete, and give a trolley clearance of 9 ft. above the top of rail. The single-track overhead construction is suspended from special galvanized, hot-riveted, steel latticed poles set in concrete. Wooden poles are used for the side tracks.

SERVICE

As the road handles package freight and express traffic as well as passengers, facilities have been provided therefor. At Grand Rapids the freight facilities are on the opposite side of the Grand River from the passenger terminal, and include a 50 x 185 ft. freight house and a team yard, as well as a repair plant. At Kalamazoo a combination passenger and freight terminal has been provided. To meet the traffic demands in the best manner, three classes of service have been inaugurated—local trains, limited trains and flyers. The flyers are single cars from Kalamazoo and Battle Creek to Monteith Junction, where they are coupled together and run to Grand Rapids as two-car trains. The shorter run, that from Kalamazoo to Grand Rapids, a distance of 50 miles, is made in 1 hour and 10 minutes. The limited train takes slightly longer, and the local trains require 1 hour and 45 minutes and 2 hours and 25 minutes respectively from Kalamazoo to Grand Rapids and from Battle Creek to Grand Rapids.

The work of building the new line, and electrifying the steam road running to Battle Creek and Allegan, was under the immediate supervision of George L. Erwin, president and general manager of the Michigan Engineering Company, and G. J. Wagner, superintendent of construction. During the construction period the Michigan Railway was represented by the late W. A. Foote, vice-president, who promoted the line and was responsible for many of its unusual features.

STATE-AID ROAD-IMPROVEMENT SURVEYS made by the Wisconsin Highway Commission from July 1, 1911, to July 1, 1914, cost $27,165 for a total of 2567 miles, an average of $10.58 per mile. In addition 182 miles of surveys were made by representatives of the counties, which were not paid for by the commission, making a total of 2749 miles of State-aid road surveys. During the past winter the commission made surveys and plans for 500 miles of road, at approximately $7000.

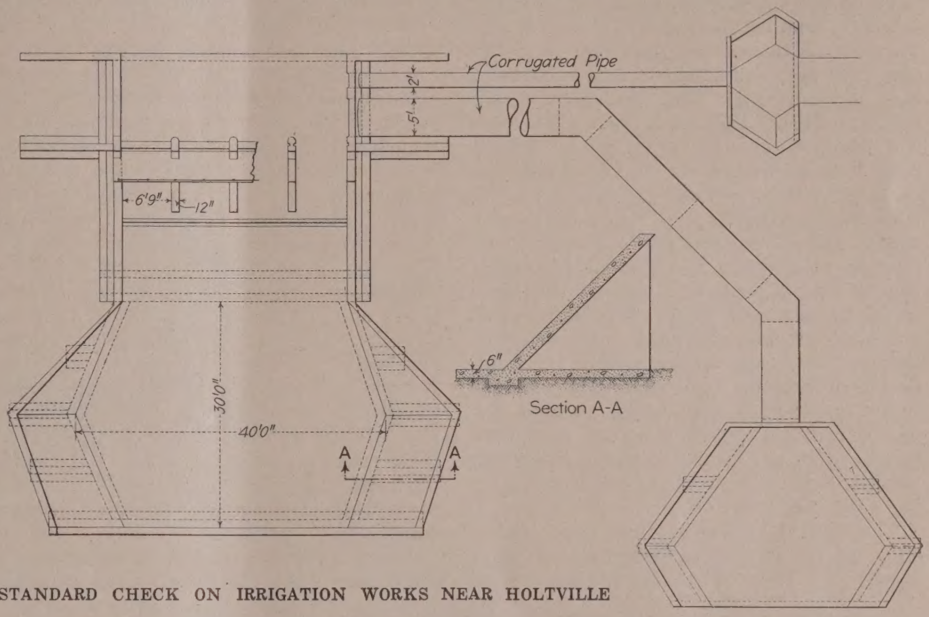
Bowl Outlets Reduce Velocities at Pipe-Line Ends

Enlarged Concrete Sections Used at Entrance Ends of Main and Diversion Channels of Irrigation Project in California

DIVERSION of water from the main canal of Imperial Water Company No. 5, near Holtville, Cal., is accomplished at three points by concrete checks from which the water is led in metal pipes some 20 ft. away from the main structure to prevent the possibility of erosion and back-cutting from the discharge. In one case two American ingot-iron corrugated pipes of 5-ft. and 2-ft. diameter respectively had their intake ends embedded in the side wall of the check, while the outlet ends discharged into a concrete bowl, 4 ft. deep and 28 and 10 ft. in diameter, designed to reduce the velocity so as to prevent erosion of the unlined canal earth banks beyond the bowl. The 5-ft. pipe feeds a side main paralleling the supply canal. To make the necessary turn two 45-deg. elbows, placed 20 ft. apart, were employed. All joints made in the field were riveted and soldered, substantial mudsills were placed under the pipe and earth was puddled carefully around it. Control of the outlet flow is attained by wooden gates moving in iron channels embedded in the concrete walls of the check and operated by lift screws. The engineer states that the structures are watertight and satisfactory in operation.

In this district several corrugated-iron inverted siphons for the purpose of carrying storm water and waste irrigation water under a low-line main have been used. The intakes and discharges consist of vertical walls of reinforced concrete or of treated Oregon pine. With concrete the pipe is simply embedded in the walls, but with wood the pipe is let into the wood and the joint calked with oakum. Pipe has been selected where the concrete materials run high in cost.

Roger Laurence is chief engineer of Imperial Water Company No. 5 and has immediate charge of all construction work, which is carried out by force account.

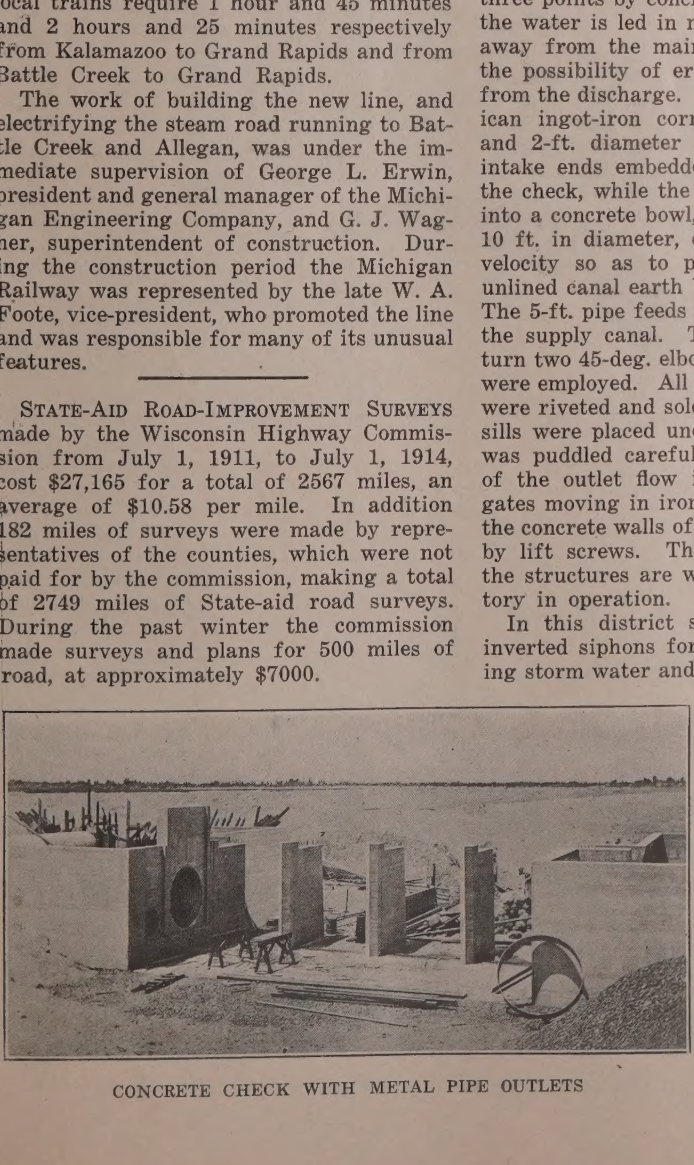


STANDARD CHECK ON IRRIGATION WORKS NEAR HOLTVILLE

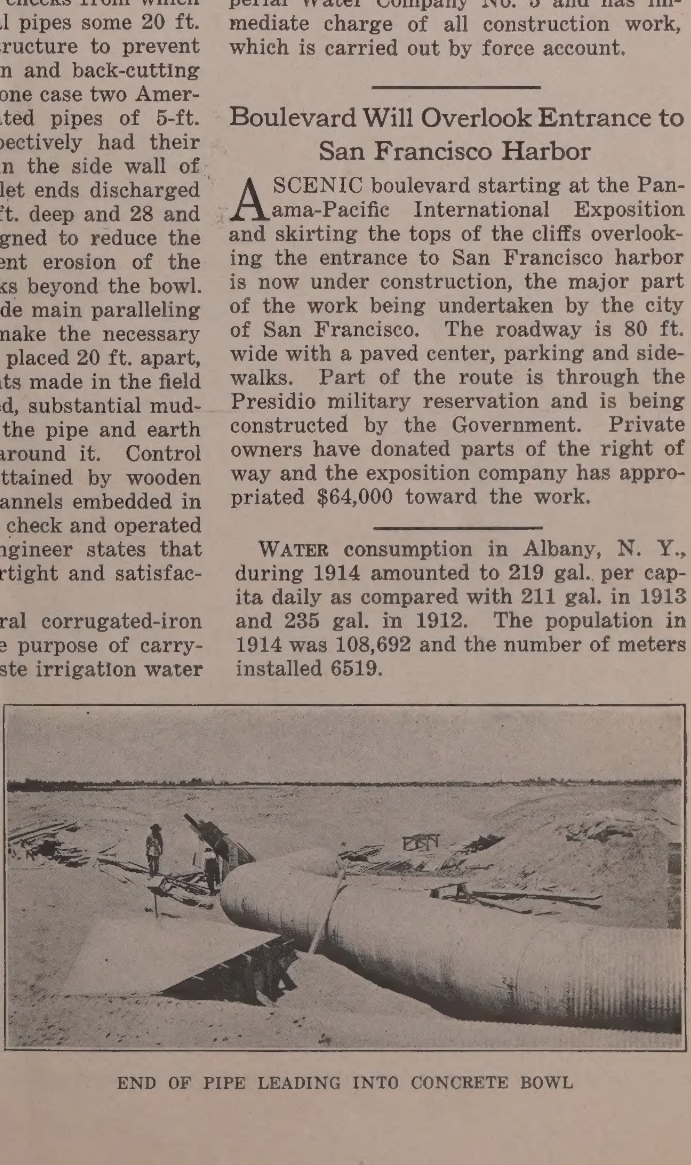
Boulevard Will Overlook Entrance to San Francisco Harbor

A SCENIC boulevard starting at the Panama-Pacific International Exposition and skirting the tops of the cliffs overlooking the entrance to San Francisco harbor is now under construction, the major part of the work being undertaken by the city of San Francisco. The roadway is 80 ft. wide with a paved center, parking and sidewalks. Part of the route is through the Presidio military reservation and is being constructed by the Government. Private owners have donated parts of the right of way and the exposition company has appropriated $64,000 toward the work.

WATER consumption in Albany, N. Y., during 1914 amounted to 219 gal. per capita daily as compared with 211 gal. in 1913 and 235 gal. in 1912. The population in 1914 was 108,692 and the number of meters installed 6519.



CONCRETE CHECK WITH METAL PIPE OUTLETS



END OF PIPE LEADING INTO CONCRETE BOWL

Tunkhannock Viaduct Nearing Completion

Last Steps Include Concreting Arch Ribs and Spandrel Walls Through Upper Panels of Central Cableway Tower

THE MAIN RIBS for the center arch of the Tunkhannock viaduct, which have just been concreted, were built through two bays of the central double cableway tower without stopping operation of the cableway. This tower rises more than 320 ft. above the creek bed, and supports four cableways, two on each side. The viaduct, 2375 ft. long and 240 ft. high from the creek level to the parapet, is now nearing completion, only 6000 of its 162,000 cu. yd. of concrete masonry remaining to be placed. It consists of ten 180-ft. and two 100-ft. arch spans, and is the largest structure of its kind in existence. The viaduct is part of the 43-mile Nicholson cut-off of the Delaware, Lackawanna & Western Railroad in northeastern Pennsylvania. Its construction, including special features of the foundation work, the arch centering and the twin double-span cableways, erected for handling centering and concrete, have been described in the issues of the Engineering Record of May 3, 1913, page 484, and Nov. 29, 1913, page 594.

The central cableway tower is of timber on concrete pedestals midway between piers 5 and 6. The timber tower consists of three bents, parallel to the bridge, of three posts each. The faces of the tower perpendicular to the bridge are battered, while those parallel to the bridge are vertical. The central bent is located between the main arch ribs, which are in pairs for each span, while the outside bents are entirely clear of the concrete construction.

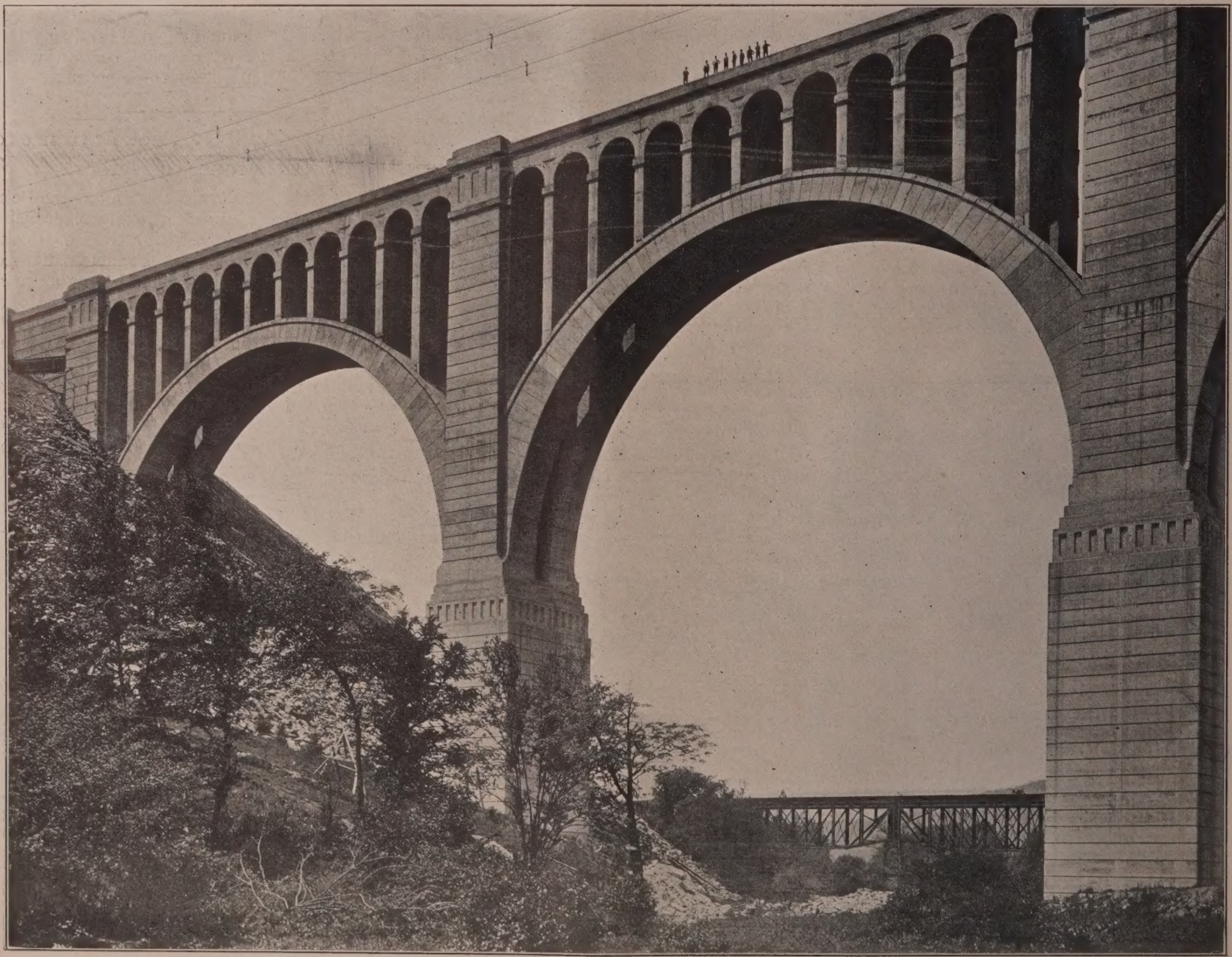
CENTERING FOR LAST ARCH SPAN SET

As will be remembered from the former articles, each arch center is in four sections. The four sections next to the piers for the two sets of centering are entirely clear of the tower, and were set first. The four middle sections were then erected by temporarily removing one panel of X-bracing on each face of the tower and replacing it through the framework of the centering after the latter had been set. The X-bracing in the panel above was then removed to allow the rib concrete to be poured.

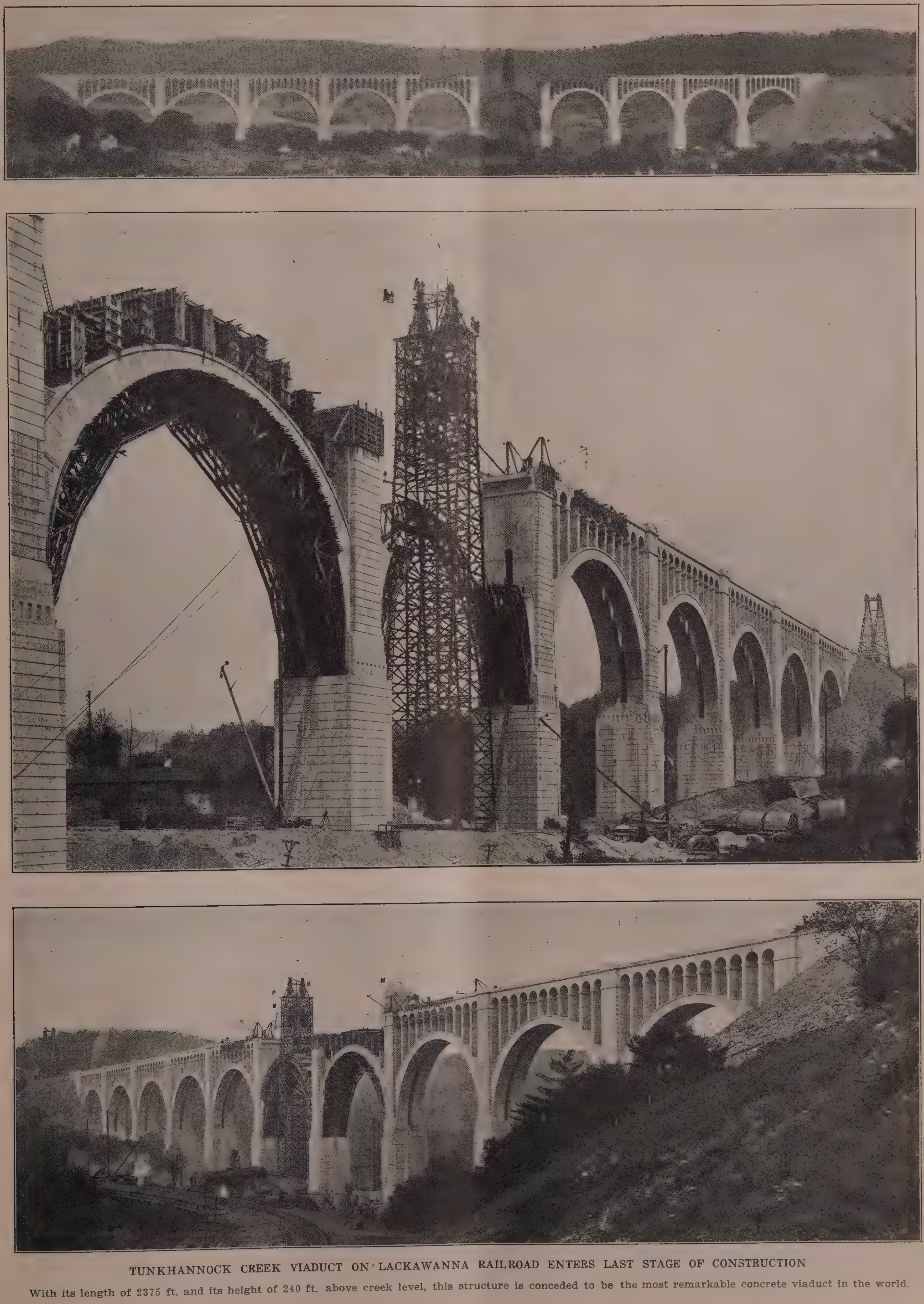
Between each of the batter faces of the tower and the three center posts on a line at right angles to the viaduct comes a spandrel wall. To concrete these two walls the X-bracing is removed in one panel between the three posts of the bent between the arch ribs. In concreting the floor of the viaduct three small square holes will be left for the three posts of the center bent. The concrete clears the cableway tower at all other points.

This construction was all planned at the time the cableway was designed. When the last arch centers had been set, the last remaining clear hoistways through which the cableways could reach the ground were blocked. Provision had to be made, therefore, for raising concrete buckets from the tracks on the floor of the valley to the bridge deck and transferring them to the cableways. This is done by four derricks, two on top of pier 6 and two on pier 4. Pier 5 was not used, as it was not quite finished at the time the last arch centers were set. Because of the smaller hoists used, it takes 90 seconds to hoist a bucket with a derrick as against 30 seconds with the cableway. Buckets can be handled right to the face of the tower, and dumped into hoppers, the concrete being spouted the short distance remaining to the center of the arch. Two yards has been the standard concrete unit handled on the job, and 30 cu. yd. per hour, or better, have been placed for each cableway span in service.

The cableway tower construction was planned by Lincoln Bush and engineers of the Lidgerwood Manufacturing Company. Flickwir & Bush are the contractors for the viaduct, and F. M. Talbot is general manager of the company. The design and construction of the viaduct has been under the direction of G. J. Ray, chief engineer of the Delaware, Lackawanna & Western Railroad. F. L. Wheaton is engineer of construction in charge of the entire cut-off work, and A. B. Cohen, concrete engineer, handled the design of the viaduct.



CLOSE VIEW SHOWS ATTRACTIVE PROPORTIONS OF STRUCTURE AND GIVES AN IDEA OF ITS MAGNITUDE



TUNKHANNOCK CREEK VIADUCT ON LACKAWANNA RAILROAD ENTERS LAST STAGE OF CONSTRUCTION

With its length of 2375 ft. and its height of 240 ft. above creek level, this structure is conceded to be the most remarkable concrete viaduct in the world.

Driving and Lining Carried On Simultaneously at Snoqualmie Tunnel Saved Timbering

Drift Driven Along One Wall from "Shafts" Sunk in Bench in East Heading Allowed Most of the Bench Excavation to Be Trapped Into Cars at Subgrade

By R. W. RAE
Chief Engineer, Cascade Irrigation District, Ellensburg, Wash.

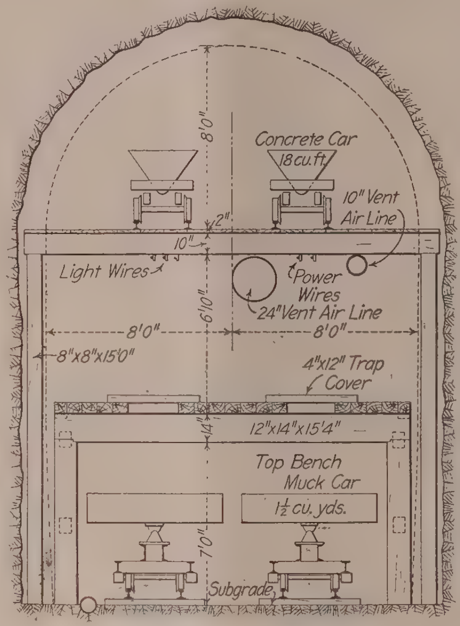
TO SAVE TIMBERING concrete lining was placed as excavation progressed in the arch of the top heading at the east end of the Snoqualmie tunnel, sixty miles each of Seattle, which was opened for traffic early this year. Concrete and muck were handled simultaneously by a dinky at the level of the top of the bench. Meanwhile a heading in the bench along one side was driven from "shafts" sunk in the bench and used to operate a low-level railway into which the bulk of the bench excavation was trapped. From the west end the bottom-heading method was used with economy and speed. Concrete was handled here on an 8000-ft. cable-car line in trains of cars provided with grips. The fact that the new line was 443.5 ft. lower than the old location was turned to good advantage in laying out concrete plants at either end of the 11,902-ft. tunnel. The work was done entirely by the railway company's own forces.

On Jan. 24, 1915, the first regular train passed through the tunnel. Although work on this tunnel was authorized in July, 1910, little was done until March, 1913, and the bulk of the construction has been accomplished since that time. During this period work was prosecuted day and night with a force of from 500 to 2000 men. Some idea of the saving in distance, grade and curvature effected by the relocation may be gained by referring to the article in the Engineering Record of Feb. 13, 1915, page 193.

BOTTOM HEADING PREFERRED FOR WEST PORTAL

The tunnel was driven entirely from the two ends. At the west end a bottom heading 7 x 13 ft. was first driven. This was winged out to the full width and timbered. Upraises to the crown of the arch were then driven 150 ft. apart, after which stopes were driven in both directions from each upraise until they met, all muck being handled by gravity, through traps, into 1½-yd. side-dump cars.

In ordinary ground 8-ft. rounds were drilled in the stopes, consisting of approximately twenty holes. The rock encountered was mainly a hard black slate, although short sections of granite and extremely hard quartzite were also found. The irregularity of the rock formation was the most difficult feature in the driving of the tunnel. In many heading rounds the rock on one side was so much harder than that on the other that two machines would be through drilling several hours in advance of the other two, making it necessary to crowd all the machines on one side of the bar to complete the drilling on the hard side. The uncertainty of the ground made it impossible to judge with any accuracy just when a shot could be put off. The time necessary for drilling an 8-ft. round varied from 3 to 20 hr.



MUCK AND CONCRETE EQUIPMENT FOR BOTTOM HEADING

DEEP PORTAL CUT NECESSITATES TOP HEADING AT EAST END

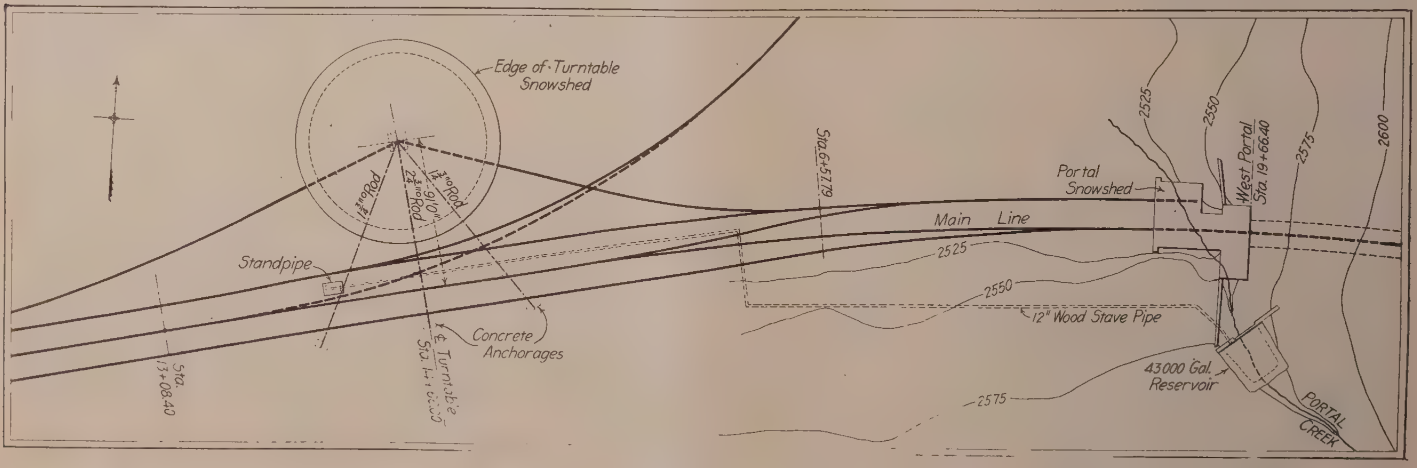
Owing to the long portal cut at the east end of the tunnel it was found necessary to adopt the top-heading plan of driving to avoid waiting an additional three months for the excavation of the approach. The top heading, 7 x 13 ft. in size, was driven at the crown of the arch and later winged out to the full width of 18 ft. The floor line of the heading was taken out to 1 ft. above the spring line of the arch, so as to reduce as much as practicable the amount of muck to be handled at the higher level. For taking out the bench a drift of 7 ft. high by 9 ft. wide was driven along the south wall and timbered with square sets. Everything above the timbering was trapped, the rectangular section of the bench left at subgrade being broken up and hand-mucked after the trap timbers were removed. In order that this bottom drift might be kept well in advance of the trapping forces shafts were sunk at intervals of approximately 800 ft. from the heading to subgrade, and drifts worked either way from each shaft. The muck from these shafts and drifts was handled in 1-yd. steel rocker cars, which were hoisted to the heading grade on a cage operated by a steam hoist using air.

In the east end of the tunnel, the ground was uniformly softer than that encountered in the west end, making it necessary to put in considerable timber. The first 1500 ft. was timbered with permanent, nonremovable sets. Later, owing to the high cost of this class of work and the decision to concrete the entire tunnel, much of the arch lining was placed as the top heading progressed, thus avoiding considerable waste of timbering. All material in the top heading was handled by a 3-ton Goodman electric trolley locomotive. Cars in the drift at subgrade were handled by 7-ton steam dinkies fired with coke.

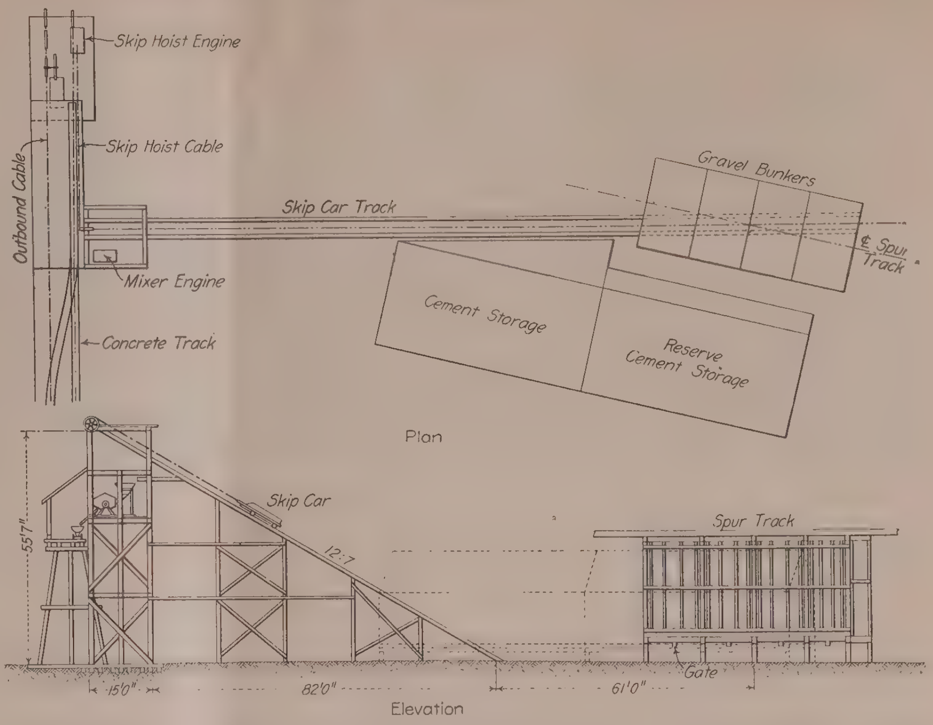
DRILLING OPERATIONS AND EQUIPMENT

Air was used at a pressure of from 90 to 150 lb. per square inch and was taken to the heading in a 6-in. pipe line. Ingersoll-Rand piston-type drills, mounted on a horizontal bar, were used in the heading, and a great many jackhammers were used on the bench and for trimming. Drills of 3¼-in. diameter were used as starters, and 1¾-in. drills to finish up. The cross bar on which the piston machines were operated was set about 4 ft. above the bench.

Ordinarily sixteen 8½-ft. holes were drilled to a round, twelve being above the cross bar and four below as lifters. The average horizontal break was about 7.3 ft. Holes were not sprung except in unusually hard ground. From 3½ to 9 boxes of 60-per cent dynamite were required for each



CREEK BED WAS CARRIED ACROSS WEST PORTAL STRUCTURE AND THE WATER WAS STORED FOR USE OF LOCOMOTIVES round of sixteen holes. Fuses were used throughout the work. An average of 8 lb. of powder was required for each cubic yard of material removed. All muck was shot upon steel sheets to facilitate shoveling. The best progress made in the east heading was 433 ft. in one month, and as much as 500 ft. of the bench in this heading was removed in one month. The trap to the east heading was maintained as its original high level throughout the work, being supported on 8 x 12-in. timbers placed 5 ft. apart at the spring line of the arch and posted to subgrade.

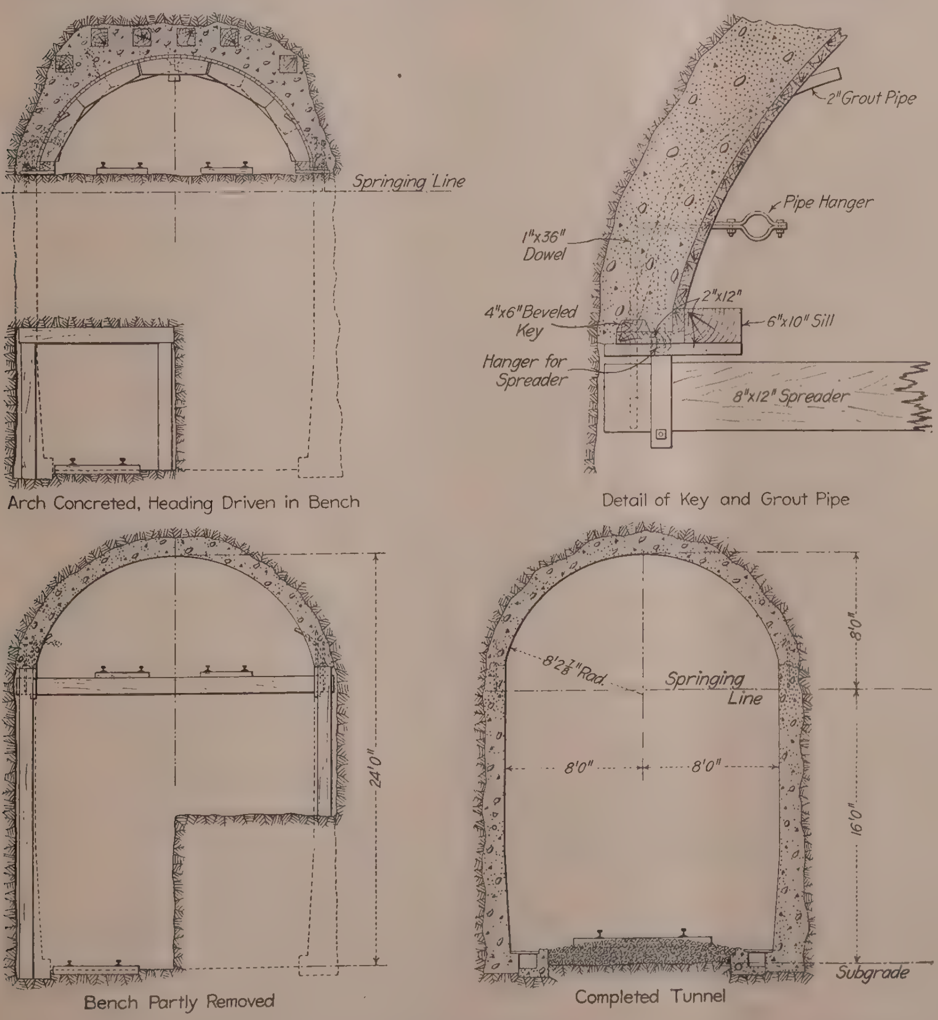


LOW DELIVERY OF MATERIAL AND HIGH ENTRANCE TO HEADING ARCH GOVERNED LAYOUT OF CONCRETE PLANT AT WEST PORTAL

CABLE CARS CARRY CONCRETE AT WEST END

The aggregate for the concrete used in lining the tunnel was obtained from a gravel bank on the right-of-way of the railroad 15 miles from the west portal. It was sluiced into cars at a cost of about 4 cents per yard, and one train load was delivered to each end of the tunnel every day while concreting was going on. The difference in grade between the old main line and the tunnel portal was taken advantage of in locating the spur at the west end for the delivery of gravel so that the cars dumped directly into storage bins over the mixer. The gravel storage consisted of four bins with a total capacity of 350 cu. yd. The cement shed at the west end had a capacity of 4000 bbl. The gravel was handled by one man, and the cement by two men.

Concrete materials were hauled from the bunkers and cement shed in a mine skip running on an incline and dumping directly into the ¾-yd. Smith mixer. Concrete was handled from the mixer in 18-cu. ft. dump cars over a high line built at the level of the top of the bottom heading. As all muck at this end was handled at the level of the tunnel floor, this track did not interfere with the muck cars, and was only used for concrete. The cars were operated by a ¾-in. endless wire rope traveling at a speed of 4 miles per hour. Each train was attached to the cable by a grip which was released at the desired point by a trip. The slack was taken out of this cable by a counterweight adjusted outside the tunnel. This counterweight was hung to a carriage holding a sheave around which the track cable passed. The carriage was free to move up and down an inclined track. The main cable was operated by a 75-hp. hoisting engine.



Arch Concreted, Heading Driven in Bench

Detail of Key and Grout Pipe

Bench Partly Removed

Completed Tunnel

ADVANTAGES OF TRAPPING LARGE PART OF EXCAVATED MATERIAL RETAINED EVEN WITH TOP HEADING METHOD ON EAST END

From six to ten trains were used in hauling concrete, depending on the distance from the portal at which concrete was being poured. The material was dumped directly into the side walls, and into a box between the tracks, from which it was shoveled into the arch forms. The limit of cable haulage was 8000 ft. Twelve hundred linear feet of tunnel were lined from one end in a month with this layout. Ground pipes inserted every 12 ft. in the roof were used to complete the concreting of the arch. From 15 to 600 cu. ft. of mortar was forced through each of these ground pipes.

EAST PORTAL NEARLY HALF A MILE FROM OLD MAIN LINE

The east portal was 2000 ft. away from the nearest point of the old main line and 200 ft. lower in elevation. To avoid building a long standard-gage track for materials at this end the storage bins were located 900 ft. from the main line, and an inclined track of 3-ft. gage was run from the east end to the mixer, where a small gravel storage was provided. Two V-body dump cars of 2 cu. yd. capacity each were used on this inclined railway. A gasoline-driven hoist was installed at its upper end. A second ¾-yd. Smith mixer located under the bins at the portal dumped into hopper-bottom cars running on the highline track. The electric locomotive on this track pushed empty muck cars ahead of it and pulled concrete cars, eight at a time, behind it. While the concrete was being dumped the locomotive took the empty cars to the heading and returned with a load, and while the concrete cars were being filled at the portal the locomotive took the muck cars to the dump.

This arrangement made lining operations somewhat slower than at the west end of the tunnel. As soon as the heading excavation at the east end was well started, the arch was concreted in advance of excavating the bench. In order to avoid a possible settlement when the bench was taken out, the bottom of the concrete on each side of the arch was reinforced with six ½-in. square bars. As the bench was excavated 8 x 10-in. posts were set under the concrete at intervals of 8 ft. A longitudinal key was formed out of the bottom edge of the arch concrete on each wall, and into the top of this key on 8-ft. centers were concreted 2-in. ground pipes. The side walls were concreted up in the usual way, and the closure was made by forcing ground into the key through these pipes.

PORTAL CARRIES CREEK BED

The portal structures are of reinforced concrete, that at the east end being of the usual design. As the portal at the west end, however, was located directly under a mountain stream carrying, at some seasons, great quantities of water, the portal opening was extended 60 ft. and a double conduit built overhead to carry the creek water.

The power plants at either end of the tunnel were unusual in construction work, in that fuel oil was burned exclusively in the boilers. This oil was delivered in railway tank cars and stored in four tanks, those at the west portal holding 15,000 gal. each and those at the east portal 20,000 gal. each. The latter tanks were on a siding 2700 ft. from the portal, and oil was piped from them to the boilers. These plants, which had a capacity of 450 and 375 hp. respectively, burned an average of 120 bbl. of oil apiece each 24 hours.

COST, ORGANIZATION AND WAGES

The cost per foot of tunnel complete with track and ballast was $166. This cost is made up of $112 per foot for excavation, $44 for concrete lining and $10 for track and ballast. The quantities corresponding to these figures were: Excavation, 15.5 cu. yd. per foot, place measurement, increased to 17.5 cu. yd. actual measurement by the overbreak; and 6 cu. yd. of concrete lining per foot. These figures include all charges made against the work.

The work was in charge of J. I. Horrocks, engineer and superintendent of the tunnel, reporting to B. O. Reeder, assistant chief engineer, at Seattle, who in turn reported to C. F. Loweth, chief engineer. The office force consisted of two clerks, two head timekeepers and four assistant timekeepers. One draftsman, one paymaster and one stenographer were also attached to the office at the west portal. One engineer, assisted by an instrumentman and two chainmen for each heading, looked after all location and inspection work. The camp and commissary departments were taken over by a contractor. The working force was organized with one general foreman at the west end, and two walking bosses on tunnel work and two on concrete work. The walking boss on concrete work at each portal also handled the outside layout. One master mechanic looked after the entire job.

Outside labor received 20 cents per hour, concrete men from 25 to 30 cents per hour, muckers 25 to 27½ cents, machine runners 45 cents, helpers 30 cents, shift bosses 60 cents and carpenters 35 cents. Outside foremen received 35 and 40 cents per hour.

Old Storage Used for Oversize in Enlarged Rock-Crushing Plant on Detroit River

Since Reconstruction Large Crushers Do Not Have to Wait for Small Crushers to Catch Up on Oversize, while Oversize Can Be Sold or Crushed as Needed

IN ORDER to obtain increased capacity, continuity of operation and flexibility of production to meet the demands of the trade which require varying kinds and quantities of stone day by day, a large Michigan rock-crushing firm has recently reconstructed its plant. Stone crushed in this plant is the result of dredging operations in the Detroit River, and arrives at the plant on large deck scows. As the above operations are carried on by very heavy equipment, some of the limestone blocks received are of unusually large size, pieces with dimensions of 3 x 6 x 6 ft. not being at all uncommon.

The original plant was served by a slip at the crusher side. In order to ship finished products by water the newly constructed portion of the plant, containing additional screens, storage capacity and crushing rolls, is located on a parallel slip and connected with the old plant by two 24-in. belt conveyors.

Stone is unloaded from the scows by a dragline outfit, which swings in a full circle on its base and operates a large flat scoop-like bucket that slides along the top of the scow filling like an ordinary scraper. The bucket is then hoisted, swung over and dumped into the receiving crusher.

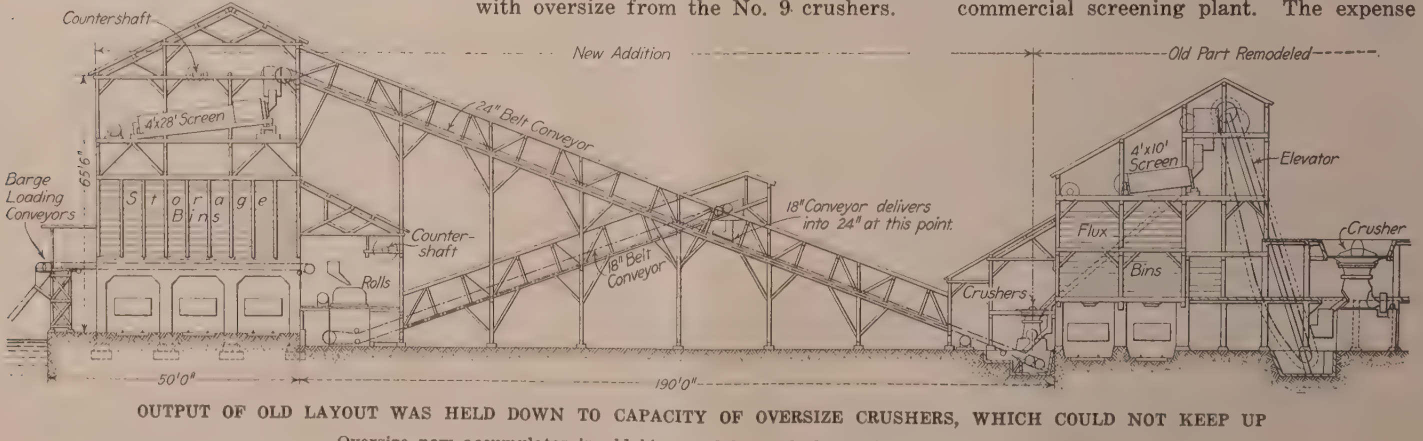
The original plant consisted of a No. 9 crusher and elevator, two 48 x 10-ft. screens, two 32 x 20-ft. screens and two No. 5 crushers for rejections, the stone passing through the several machines in the order named. The finished sizes of stone fell into a set of bins of small capacity below the screens. The plant was cramped for space and inaccessible in nearly every part, making operation difficult, but the most serious trouble was the lack of flexibility and the continual crowding of the No. 5 crushers with oversize from the No. 9 crushers.

The lower screens at the head of the No. 9 elevator in the old plant were removed, the screen floor was lowered so as to get a proper discharge from the No. 9 elevator, and the 48 x 10-ft. screens were set on this new floor and equipped with perforated coverings having 3½-in. round holes. At the same time the side walls of the old bins were raised, increasing the storage at this point.

OPERATION AFTER REMODELING

The stone is now broken in the No. 9 crusher to about 5-in. size and spouted direct to the No. 9 elevator. This raises it to the head of the plant, from which point it is spouted to the two 48 x 10-ft. screens. The spouts are so arranged that in case either screen has to be stopped for any reason the entire product may be sent through the other screen by operating the gate. The oversize from these screens is known as "flux stone," for which there is now a separate market. It falls directly to the old storage bins below, while the undersize chutes to two 24-in. belt conveyors leading to the new screening plant for commercial stone. This arrangement permits the operation of the No. 9 crusher independently of the rejection crushers, and the No. 9 crusher is never delayed by having to wait for the rejection crushers to catch up. The changes were accomplished with few alterations of the existing buildings, and at little cost.

The two No. 5 crushers were placed side by side directly in front of the flux bins, so that they would be fed automatically from chutes in the sides of the bins and would discharge their product directly upon the two 24-in. belt conveyors leading to the commercial screening plant. The expense



OUTPUT OF OLD LAYOUT WAS HELD DOWN TO CAPACITY OF OVERSIZE CRUSHERS, WHICH COULD NOT KEEP UP

Oversize now accumulates in old bins, and is crushed or sold according to demand.

PLANT HAS RAIL AND WATER DELIVERY, AND STORAGE FOR ALL SIZES, AND CAN RE-CRUSH CHEAPLY TO SUIT MARKET

of this change amounted to new foundations for the No. 5 crushers and a new light frame building over them.

This arrangement of the rejection crushers makes them independent of the No. 9 crusher and permits their constant operation so long as stone remains in the flux bins. They can be run to maximum at all times; in case of accident, or if repairs to one crusher become necessary, the flux-bin gate is closed and the other crusher kept at work, the oversize in the meanwhile accumulating in the flux bin. Again, in case of an extra demand for commercial stone and a light demand for flux, the No. 5 crushers can be run overtime, and at night if necessary, recrushing all of the rejections down to commercial stone, while the No. 9 end of the plant is closed down.

The 24-in. belt conveyors leading from the No. 5 crushers are inclined from the horizontal, thus elevating while conveying the stone. Each discharges at its upper end into a 48 x 28-ft. revolving screen provided with dust jackets and sections perforated to give the various sizes of stone called for by the Detroit market. The undersize from the dust jacket of each screen falls to the floor below to a 36 x 90-in. shaking screen, which separates the screenings from the fine stone. Interposed between the revolving and shaking screens is a pneumatic device which takes the fine dust out of the stone and delivers it to a separate section of the bins, thus cleaning the screenings and at the same time making this objectionable dust a valuable by-product.

ECONOMICAL CONSTRUCTION

Sized stone from the screens falls below to the storage bins, which have a capacity of 1750 cu. yd. and are of combined concrete and timber, specially designed for construction economy. The footings, columns and floors of these bins are of reinforced concrete, while the bin walls consist of heavy timber posts sheathed with 3-in. planks and cross-stayed with heavy tie rods. By this scheme of construction the bins were built with only about 300 cu. yd. of concrete and 50,000 ft. of lumber. The lower posts and floor, which are subject to rot, were replaced with concrete, and the bin walls, which would be expensive to build of concrete because of the amount of form work required, are made of timber.

A belt conveyor under the bins delivers commercial stone directly to scows in the slip, or, running in the reverse direction if necessary, delivers oversize and material to be recrushed to electrically driven roll crushers located to the right of the bin. The product from these rolls is carried by an inclined 18-in. conveyor to the 24-in. conveyor, thence to the top of the screening plant.

Three loading tracks run directly through under the bins and suitable gates are provided in the floor of each bin for loading railroad cars. The new plant was designed and its construction supervised by the J. C. Buckbee & Company, consulting engineers, of Chicago.

University Promotes Engineering Work without Displacing Consulting Engineer

Extension Division, in Fact, Creates New Work for Consultants by Urging Needed Measures on Smaller Communities

By GEORGE R. BASCOM

In Charge of Municipal and Sanitary Engineering Department, Extension Division, University of Wisconsin

THERE are few engineers in private practice who will not admit that there is very often a great need of some system of educating the public to the necessity of making certain public improvements. The problem of popularizing the engineering features of any public improvement and getting the public opinion aroused to action is a matter of promotion rather than engineering, a matter of salesmanship rather than design, and a problem in publicity in its final analysis.

If it is true that the cities, villages and communities quite generally need improvements which have a direct bearing on the health, economics, and general welfare of these places, would it not be a matter of economy and efficiency to create some system by which this engineering promotion or this education could be systematically and impartially carried on? There is little doubt that most engineers in private practice will agree with this, providing the work is carried on impartially and providing the service given is limited in such a manner that the legitimate business of the engineer in private practice is not taken over by the new agency. Of this the writer has been reassured by a great many opinions which were solicited prior to beginning the work in Wisconsin and have been sought at every opportunity since. It is quite interesting to note that in not a single case did the engineers consulted disapprove of the service when so limited. In many cases we have met with hearty approval and offers of co-operation that have been an inspiration in our work, which is truly pioneering.

The following account will show how the services of the Extension Division of the University of Wisconsin are offered in promotion work.

WATER SITUATION AT BLOOMINGTON

About a year ago the division held a three-day Community Institute at Bloomington, a town in Grant County, which lies in the extreme southwest corner of the State. In many respects Bloomington is a very remarkable village. There are less than 1000 inhabitants and yet the bank deposits are almost a million dollars! The town is located about 15 miles from the nearest railroad station. Nevertheless the stores are very much better than the average for towns of much larger size.

In spite of the fact that Bloomington is such a thrifty, businesslike little city, the people were never able to get together on the waterworks problem, which truly has been a problem with them for at least 15 years. Conditions there were such that the private well supplies were in constant danger of pollution from the privies, which, as usual, were located close to the wells. The fire losses were large and frequent. One recent fire cost the village and insurance companies more than twice the price of the proposed waterworks system. Prior to the last fire and since 1896 the fire losses in Bloomington have been more than $50,000.

SERVICE RENDERED

Probably the fact that Bloomington had voted a very large bond issue to be used as a bonus in securing a railroad outlet and had thus limited the public funds to practically $10,000 has been the main reason for delaying the installation of a public water supply. Add to this the fact that a considerable portion of the village is made up of retired farmers, who opposed the idea, and we have the situation pictured about as it was when the Extension Division took hold of the problem. There was, however, a group of live-wire business men who were willing to take every means to get the much-needed supply, and to these workers we must give credit for valuable co-operation and assistance.

At the Community Institute the writer made a plea for a waterworks system, and explained to the general audience that the Extension Division of the university would make a study of the local problem, outline a plan, and furnish an estimate which would serve as a guide in deciding the bond issue. After the meeting a group of business men discussed the details of the plan, and as a result the Extension Division was asked to make the study and present a report at the earliest date possible. This action was also formally taken at a later date by the Village Board.

BOND ISSUE VOTED

An engineer made a trip to Bloomington to gather the data for a report and an estimate of cost. The expense of travel for this trip was borne by the village of Bloomington, according to our usual practice, the services of the expert being free to any community in the State.

After receiving the report the Village Board called an election on the question of voting bonds for the waterworks. The question carried 110 to 45. Oscar Knapp, president of the board, gives the Extension Division the credit for promoting the work. It was the unanimous opinion of the board that we had accomplished what seemed impossible and had engineered a project which had met defeat at the polls several times before.

A second trip was made at the suggestion of Mr. Knapp and at that time the board was urged to secure the services of an engineer in private practice to prepare detailed plans and specifications and to take charge of the work and carry it through to completion.

SELECTION OF ENGINEER

Then came the question of selecting an engineer, and we had to devise some means of assisting Bloomington in securing a competent engineer without suggesting any names. We were asked outright to recommend a man for the place, but the writer was of the opinion, and still is, that the surest way to put an end to this service was for the department to suggest the engineer for the work. We, therefore, adopted a simple plan which has worked out entirely to our satisfaction, since it has relieved the department of all responsibility of indicating the choice of an engineer. We furnished the Bloomington board a list of all the waterworks systems in the State and advised them to write any or all of the places for detailed information regarding the engineers who had charge of work, what the results were, and for any other information leading to the selection of a competent engineer.

Shortly thereafter Louis P. Wolff, M. Am. Soc. C. E., was retained as the board's selection, and as a result of his independent investigation plans and specifications were prepared in detail. The original outline plan as covered by the Extension Division's report has been followed except for a few minor changes. Our report gave only a "ground-floor" plan of the system with no detailed plans or specifications, and hence was of value only in suggesting a method and in promoting the work.

ONLY PROMOTION SERVICE OFFERED

It can thus be seen that in this service we are advising, guiding and inspiring rather than serving in an engineering capacity in its fullest sense. We believe that we are filling a real need, for the work has thus far clearly demonstrated the fact that communities will take the impartial advice of the university departments where the overtures made by individuals in the promotion of public improvements may be viewed with suspicion. In this work we are trying to advise against unnecessary expense as well as encourage new improvements, and since we neither sell material nor collect fees our advice is effective with the average layman. Bloomington stands out as a striking illustration of this fact, for we were able in one year to accomplish what the community at Bloomington was unable to do for more than 15 years, and in spite of the fact that a competent engineer previously had made a report on the waterworks problem.

It is the writer's firm conviction that with the proper support this work will be the means of promoting better sanitary conditions in the State in a most effective and direct way, and at the same time in a manner which will create added business for the engineer in private practice.

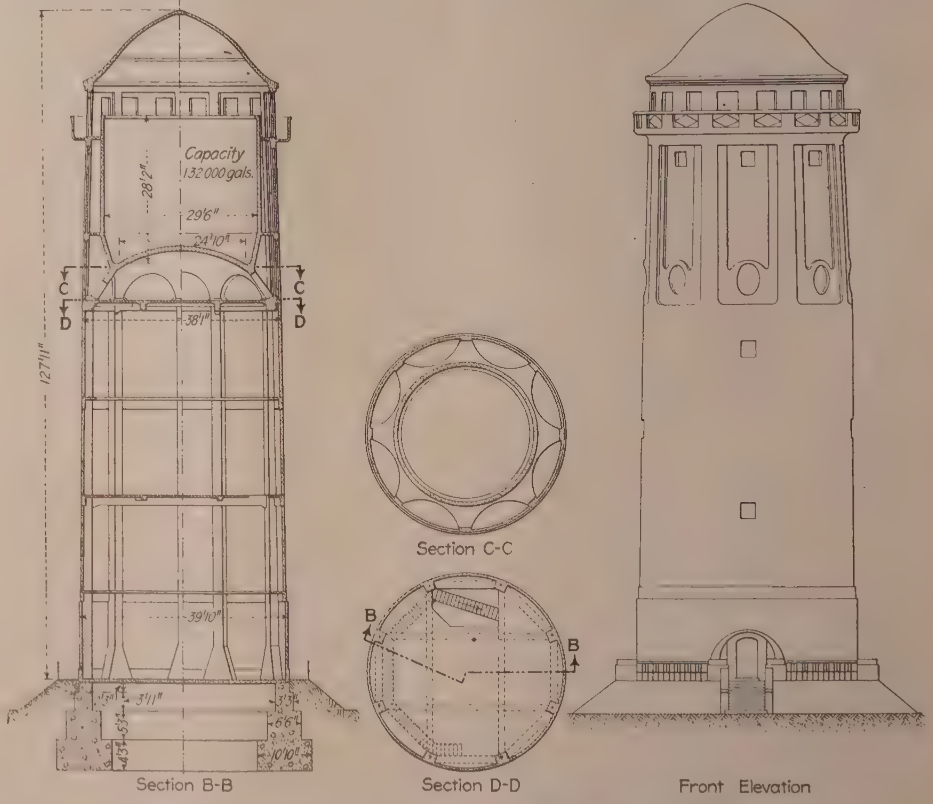
The waterworks problem is only one of the branches of municipal and sanitary engineering in which this department of the Extension Division is offering assistance and advice. Such problems as sewage disposal, pavements, garbage disposal, etc., are also covered and many requests for service in these lines have been received. In giving assistance in this service the best advice which can be obtained is given, and we *always* urge the people to secure a competent engineer where the work requires such services. In this connection it should be understood that the engineers engaged in this work are not engaged in private engineering practice; hence are in no way benefiting personally from the business created.

Appearance Considered in German Water Towers

Great Weight Given to Architectural Features of Reinforced-Concrete Tanks—Circular or Octagonal Supporting Structures Used

ARCHITECTURALLY pleasing results have been attained in recent developments in the design of water towers for the support of tanks in the vicinity of various cities in Germany. In the March issue of "Armierter Beton" is an article by Diploma-Engineer Spangenberg, director of the firm of Dykerhoff & Widmann, of Dresden, describing several types of water towers constructed under the supervision of the author and located at Edingen, Hockenheim, Strassburg, Stromeyersdorf, and Karlsruhe. The accompanying illustrations of two of these towers illustrate types of construction which are claimed to be economical and wholly satisfactory. All of these towers support circular reinforced-concrete tanks of a design which has become fairly well standardized in German practice.

The water tower designed for the city of Hockenheim to support a tank of 132,000-gal. capacity was selected from many other competitive designs, and the decision in its favor was influenced largely by its architectural features. The general dimensions and structural treatment of the reinforced-concrete supports are shown in the sections herewith. Of particular interest is the arched or domed construction by which the tank is supported on top of the eight rectangular main columns without the use of any beams and without bending the



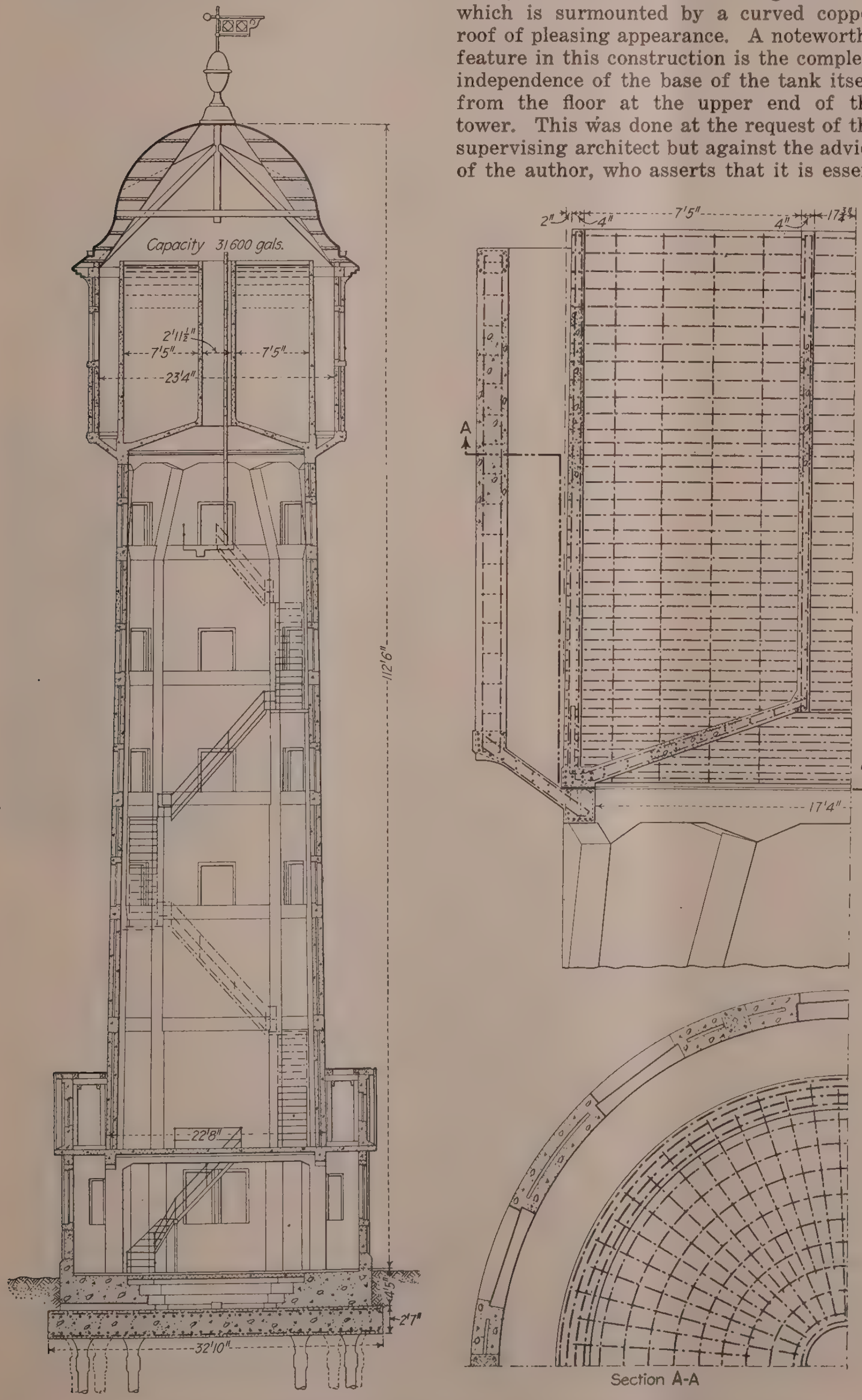
WATER TOWER FOR CITY OF HOCKENHEIM SELECTED FROM MANY DESIGNS columns, the outward thrust being resisted by the reinforced-concrete beams and floor at the top of the columns as shown.

Entrance to the outer gallery at the top is furnished by circular stairs above this floor and in the insulating space between the tank and the surrounding wall. The architectural effects were obtained mainly by the use of the curved roof, the outside gallery and balustrade, decorative panels finished in color, and the treatment of stairs and entrance at the base.

TOWER AT STROMEYERSDORF

The type shown in the accompanying section of the tower at Stromeyersdorf is used when access to the upper part of the tank cannot conveniently be obtained through the air space provided between tank and inclosing wall used for insulating purposes. It is then necessary to use a vertical ladder, as shown, passing through a cylindrical opening through the center of the tank, the capacity of which is thus decreased. The tank here shown is of about 31,000-gal. capacity. The general dimensions of both tank and tower are given, and the sections indicate the position of the reinforcement in the sides and bottom of the tank.

The tower foundation had to be made of a square reinforced-concrete footing on piles, as shown, due to the very low supporting power of the soil. The octagonal construction and interior stairs are indicated by the main section, which also shows the small machinery house at the base which acts as part of the tower itself. The insulating space at the top is provided by the cylindrical walls surrounding the tank, which is surmounted by a curved copper roof of pleasing appearance. A noteworthy feature in this construction is the complete independence of the base of the tank itself from the floor at the upper end of the tower. This was done at the request of the supervising architect but against the advice of the author, who asserts that it is essentially irrational and uneconomical thus to separate the circular tank base from the floor at the top of the tower. The latter could be used to furnish the required resistance to outward thrust, as in the case of the design previously described, without the necessity for providing heavy circular reinforcement at the base as shown in this design.



STROMEYERSDORF WATER TOWER BUILT ABOVE SMALL MACHINERY HOUSE

Diver Repairs Parted Intake Line at Evanston

Pipe Laid in Lake Michigan Floated by Air or Shifted by Storm Sufficiently to Allow Spigot to Separate from Bell

LAST FALL the 36-in. intake through which the pumping station at Evanston, Ill., obtains water parted about 100 ft. from the dock line, in 12 ft. of water. At this point the sand cover ends and for the remainder of the 5000 ft. the line is uncovered and rests on a clay bottom.

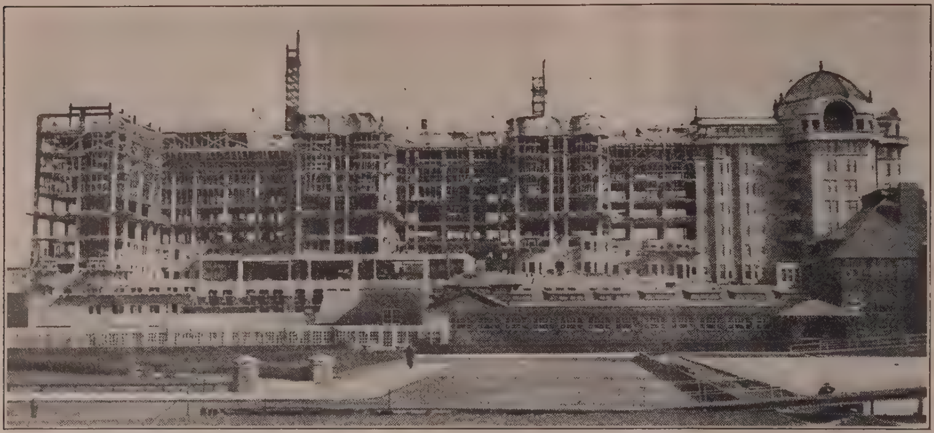
In repairing the break it was impossible to get the spigot back into the bell, so the latter was cut off after taking the length of pipe to shore. The cut was made far enough back of the bell to leave about 4 in. between the ends at the original break when the opposite end was pulled home in its bell. It was necessary to pull one or two lengths in each direction back into line. A sleeve 3 in. larger in diameter than the outside of the inner pipe was slipped over the pipe before replacing it. The 1½-in. annular ring was calked with cypress wedges and to prevent any further shifting five sets of 18-ft. piles were driven at alternate joints. Holes below the tops of the pipes were bored through the piles by a Chicago Pneumatic tool under water. Instead of inserting a band or long bolt, a chain with short lengths of 1½-in. bolts was passed over the pipe. Tightening the chain tended to bed the pipe more firmly on the bottom of the lake.

Sand found for 48 ft. in each direction from the break was removed by means of a 2½-in. water jet operating under 225-lb. pressure. The end of the jet pipe had a return bend so that the diver could push it in front of him and clear the pipe as he groped his way into the line.

CAUSE OF ACCIDENT

Opinion differs as to the cause of the accident, but the one advanced by J. G. Falcon, the diver who repaired the line, is as follows: When the filter plant was erected the overflow from the elevated wash-water tank was connected with the intake line. Air is drawn into this overflow when it operates, and occasionally air bubbles have been observed escaping from the break. Mr. Falcon believes that the pipe at some time has been floated by this air, perhaps aided by a heavy storm. He could see no other way in which the line could be parted, because the spigot end of one pipe had been pulled out of the 6-in. bell of the adjacent line and the ends were found lying adjacent to each other as though the pipe had been raised until the spigot parted from the bell and then fell back upon the lake bed again.

The waterworks officials state, however, that the pipe as parted had been drawn back nearly into line by the city diver who attempted to make temporary repairs before Mr. Falcon started work. It is their belief that the displacement may not have been caused by air.



LARGE SPREAD OF CANVAS USED TO PROTECT FLOORS POURED DURING COLD WEATHER

Reinforced-Concrete Frame of Hotel Traymore Erected at Rate of a Floor a Week

18,000 Cubic Yards of Concrete Require 1,500,000 Feet of Lumber for Forms, the Erection of Which, on Schedule, Employs 160 Carpenters

THE REINFORCED-CONCRETE frame of the eighteen-story addition to the Hotel Traymore at Atlantic City, N. J., which contains 18,000 cu. yd. of concrete, and has a total floor area of 470,000 sq. ft., was built in less than four months. This was accomplished by Cramp & Company, contractors, between Dec. 27, 1914, and April 24, 1915. At the same time the brick wall trim and tile partition work were brought almost to the top of the building, and a large share of the interior finish was completed. The construction of the frame averaged a floor a week for the four months.

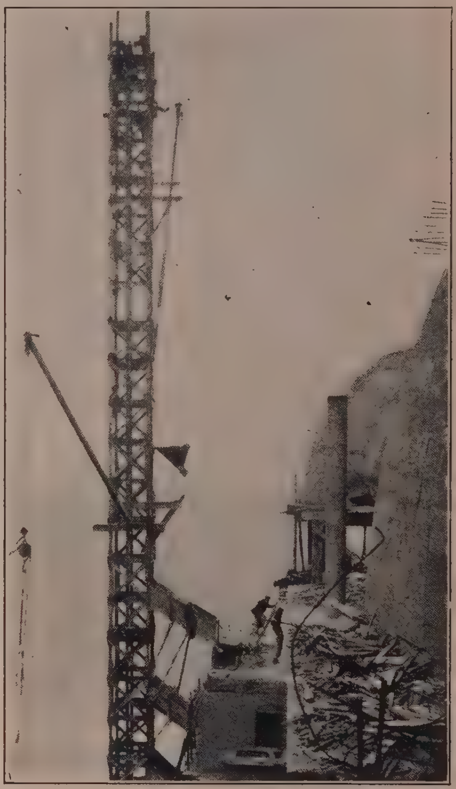
The work also involved the use of two concrete towers 256 ft. high, which is probably itself a record. In addition to the new construction the contractor, in remodeling the old reinforced-concrete wing of the hotel to match the new building, cut out two floors and replaced them with three new ones.

Work on wrecking the wooden part of the old hotel began Sept. 1, 1914. The heavy pile footings for the new structure were completed by Dec. 27, last, on which date the construction of the frame for the new building was begun. The hotel was opened to the public June 1, and the structural work and practically all of the interior finish had been completed by that date. The whole building would have been ready for occupancy but for a delay in the delivery of some of the ornamental terra cotta.

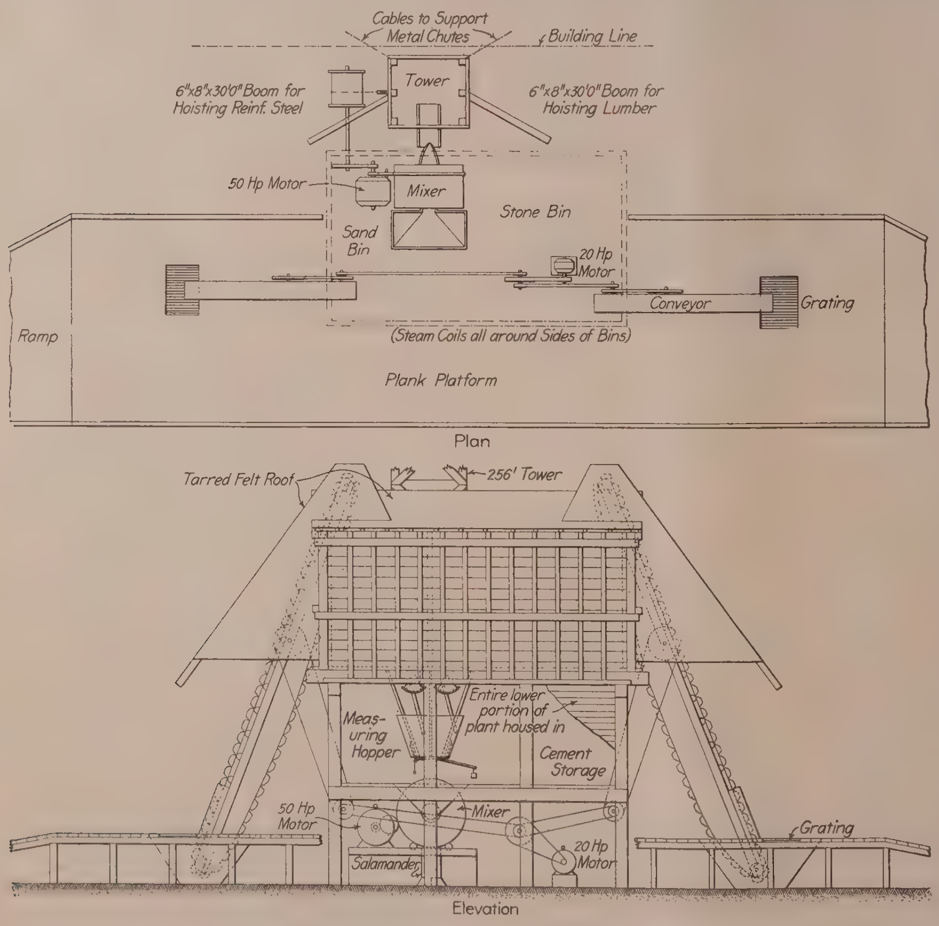
Work Organized for Rapid Progress

As will be recalled from the article in the Engineering Record of last week, page 11, the reinforced-concrete construction involved a variety of complicated form work. Only five floors of the building resembled each other sufficiently to allow forms to be used over without rebuilding. No less than 1,500,000 ft. of lumber were required for this item alone. Also, 1400 tons of reinforcing steel had to be handled and placed. Without a large and well-organized carpenter force this form work could never have been built at such a rapid rate. From 100 to 140 men were employed in the day gang, and from thirty to forty at night. Forms for the columns, beams and girders were erected in the day time, and the night crew was used simply for decking the floors. The local labor organization further handicapped this end of the job by refusing to work at night, and the night crew had to be transferred to the day shift with some loss in its effectiveness.

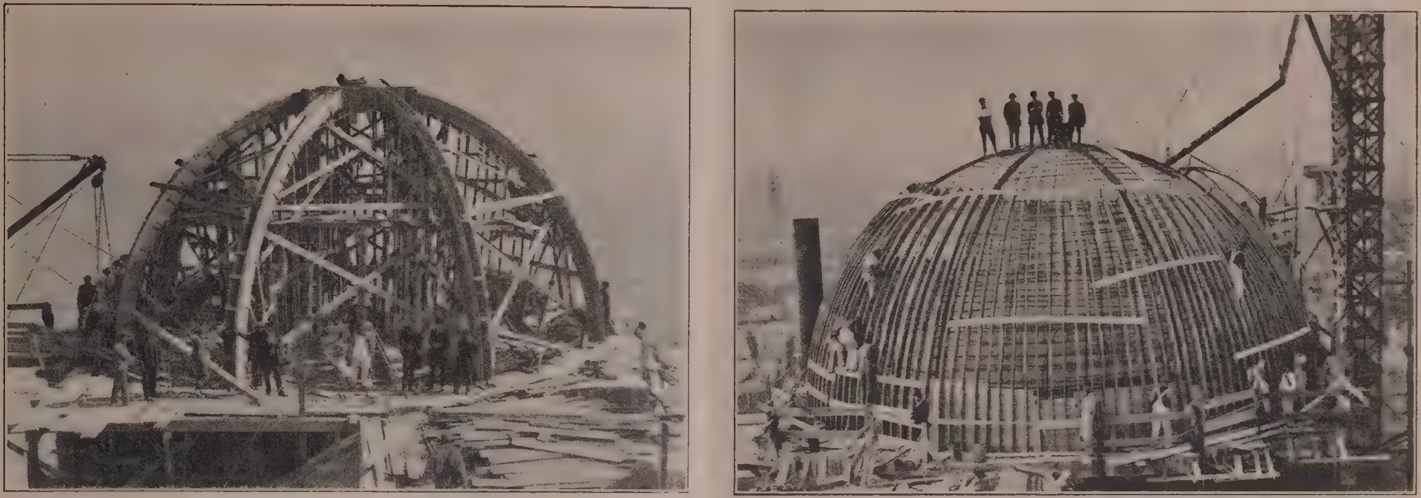
Forms were poured as fast as they could be built, and this was followed closely with the trim and partition work and cement floor finish. From sixty to seventy laborers on the day shift handled the concrete and the materials, aided by a night crew of twenty men. On the brick and tile work 130 masons were used. As bricklaying could not well be carried out except in daylight, the night shift was utilized to stock the floors with a supply of tile, brick



WOOD CHUTES ON TOWER HANDLING CEMENT FLOOR FINISH



MAIN CONCRETE PLANT HANDLED TRUCK-DELIVERED MATERIALS MECHANICALLY, AND MIXED HOT CONCRETE FOR WINTER WORK



AT LEFT, BRACING AND RIB CENTERING OF SOUTH DOME IN PLACE—AT RIGHT, NORTH DOME FORM ALMOST COMPLETE

and materials for mixing mortar for the next day.

For handling these materials an electric elevator with a speed of 800 ft. per minute was used. A fourth tower, erected between this and the south tower toward the end of the job, was used to hoist material for the plasterers. Form lumber and reinforcing were handled by booms mounted on the two concrete towers which, with the material elevator, were located on the north side of the building. These concrete towers were built to the unusual height of 256 ft., and were braced from the building.

HANDLING AND PLACING CONCRETE

The plant for mixing the structural concrete is illustrated in the accompanying drawing. It was located at the tower farthest from the beach. Material was delivered to it in the bottom-dump wagons, emptied into pits in the street, and raised to the bins by light bucket elevators. The plant at the tower next to the beach mixed the cement floor finish, and helped out the main plant when necessary, placing reinforced floor concrete amounting to less than 15 per cent of the total yardage. Both plants were equipped with 1-yd. mixers, but that for the floor finish was fed by wheelbarrows dumped into a hopper elevator.

The concrete on some of the lower floors was spouted directly into the forms for a distance of 200 ft. from the towers, but on the upper floors, due to the difficulty of carrying the spouting, the concrete was spouted only a distance of 75 ft. from the tower into hoppers, and distributed from the hoppers by concrete carts. The floor finish was distributed by carts from hoppers located above the floors on which work was going on. The two domes were poured by direct spouting.

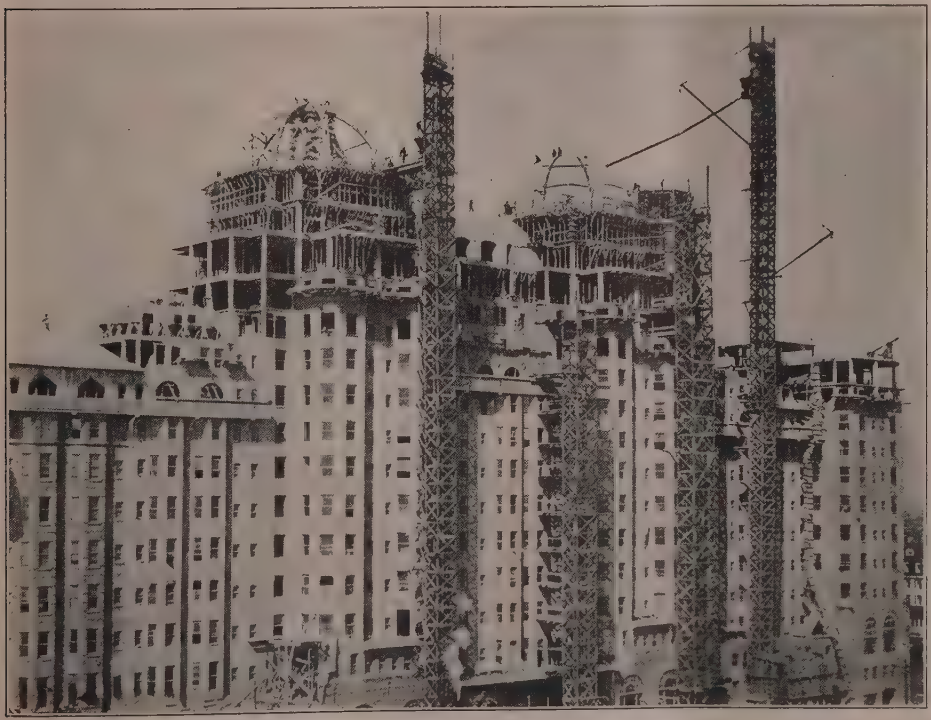
Most of the concrete and building materials were stored on vacant property at the railway siding half mile from the job, and hauled to the site by motor trucks as wanted. Cement was stored at the job in small quantities. A large cement storage was provided at the railroad siding.

Canvas covers around the outside of freshly poured floors, and numerous salamanders, were used to prevent the concrete from freezing. Steam coils were put in the bins of the main mixing plant, and the water was also heated. These precautions were entirely effective. No delays from failure of the concrete to set were experienced.

COLUMNS BRACED WHILE FLOORS ARE REMOVED

The first two floors of the reinforced-concrete wing of the old hotel were cut out and replaced with three floors to match the new structure. The interior columns, when the adjacent floors were removed, had to be braced in four directions each by timber struts set below each ceiling before the floor was cut out. For this purpose 12 x 12-in. timbers, wedged at the ends, were used. The old floors were both cut out, and forms were built and the new floors poured as in a new building. The columns were then strengthened with reinforced-concrete rings where they had pierced the old floors. After these rings had set the horizontal shores were removed and the interior was refinished.

The construction was in charge of F. V. Warren, general superintendent for Cramp & Company, of Philadelphia. Price & McLanahan of Philadelphia, were the architects for the building. The structural design was carried out by O. H. Gentner and F. Dickinson Shaw, associated consulting engineers, also of Philadelphia.



FOUR TOWERS REQUIRED TO HANDLE CONCRETE AND FINISHING MATERIALS

A WATER-WASTE PREVENTION CAMPAIGN, which will eventually result in the installation of meters on all services in Chicago, has been begun, starting with a water-waste meeting, June 9, at the City Club. The committee on water waste, E. W. Bemis, Ray Palmer and H. W. Clausen, all engineers, presented a report outlining the situation in Chicago where 40 gal. per capita go to frontage consumers, 47 gal. to meter consumers, 10 gal. to parks and other free users, 5 gal. slip through meters unregistered, 40 gal. are lost through leaky plumbing fixtures and 61 gal. through willful wastage, defective mains and service pipes. With 50 per cent of the water lost through leaks the department finds it impossible to increase the head so that fourth-floor residents can obtain water at periods of maximum consumption. Ineffectual appeals to the finance committee of City Council for aid in reducing waste have been ignored and the City Club will undoubtedly take steps now to bring the matter of metering forcibly to the attention of the city fathers.

U OF I
LIBRARY

Garbage Collection Studies in Chicago Justify Continued Use of Horses

Data Assembled for Gasoline and Electric Trucks Warrant Their Adoption Only for Hauling, After Horse-Drawn Carts Have Done the Collecting

HANDLING garbage by motor trucks was studied some time ago by the efficiency division of the Chicago Civil Service Commission, with the conclusion that the saving does not warrant the change to motors. The studies were made particularly with reference to handling garbage from the different wards to the reduction plant at Thirty-ninth and Iron Streets, or to the different loading stations, the distances varying from 1½ to 5 miles.

Garbage is collected from alleys, less than 6 per cent of which are paved. To use trucks in the alleys would mean a large number of stops, which are not economical considering the extra daily cost of the truck over horse-drawn vehicles; therefore, the report from which this material is taken is based on collections by wagon and transfer of the tank to the motor truck for hauling. The conclusions follow:

CONCLUSIONS

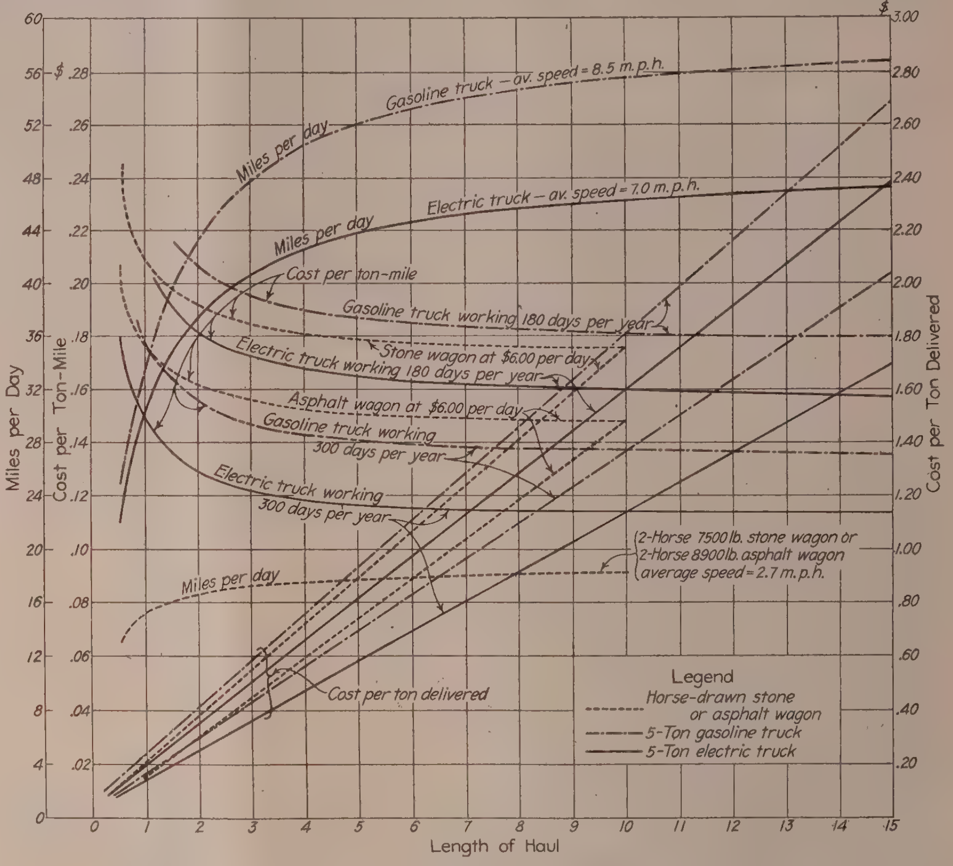
At the present prevailing cost of team hire the saving in the use of electric motor trucks for hauling garbage in such wards as have a considerable haul would amount to 5.1 per cent. If the cost of teams were increased to $6 per day the total estimated saving by using motor trucks for hauling would be about $15,775 per year, or 12.3 per cent of the total estimated cost of teams at $6 per day. These estimates are computed on the eight-hour-day basis. It has been very apparent that the present working period of garbage teams rarely amounts to eight hours per day, and that often it is as low as six hours.

In the investigation it has been found that either the gasoline or the electric power truck can handle the hauling of garbage with comparable ease. The more economical truck has been found to be the electric. This is governed in large measure by the low rate of cost of electrical energy from the Sanitary District to the city for night power, and by the fact that the collected data on the electric truck have shown lower percentage rates for depreciation, maintenance, repairs and insurance than for the gasoline truck.

The haul below which an electric truck carrying 3 tons would not be economical, when measured against a $5.50 per day team, is found to be 1.8 miles, and when measured against a $6 per day team the distance is 0.8 miles. The 3-ton gasoline truck at present cost price would not haul as economically, when traveling in the city at the economical rate of speed, as would the horse-drawn vehicle at either $5.50 or $6 per day.

The advantages of motor trucks over horse-drawn vehicles are: (a) Improved personnel of drivers, as they would be placed under civil service and would be subject to discharge for inefficiency; (b) more rapid transit of garbage from the different districts to the reduction plant or loading station, thereby causing less nuisance to the public; (c) elimination of the necessity of holding partly filled tanks in alleys, and so of such nuisance as this would cause; (d) greater mileage per day.

In comparing the costs of the two kinds of power trucks the investigators recognized that either motive power is capable of giving full service, but the factor determining the most efficient truck is measured by the cost per ton-mile for operation. Data were collected from many sources. From Marshall Field & Company were obtained statements that for average 4-ton trucks 1 gal. of lubricating oil was required per 100 miles; for electrics 1064 watt-hours were consumed per mile. Gasoline cars of this size went 4 miles on a gallon of gasoline. Depreciation, including obsolescence, were 25 and 12½ per cent for gasoline trucks and electrics respectively. In this connection the report points out that it must not be overlooked that the average run for the gasoline trucks is from 25 to 30 per cent greater than for the electrics; also that this advantage is due to fewer stops and greater speed possible on the kind of haul assigned to the respective cars.



HORSE-DRAWN WAGONS AND GASOLINE AND ELECTRIC TRUCKS COMPARED

GASOLINE VS. ELECTRIC TRUCKS

The basis of the comparative estimates of gasoline and electric trucks was as follows:

Interest at 4 per cent on truck value, assuming that money can be obtained at 5 per cent and will draw an average of 1 per cent on total sum when placed in bank as depreciation accrues.

Insurance (fire and liability)—gasoline 3 per cent plus $70 per annum, electric 3 per cent plus $63 per annum.

Garage rates, varying from $15 to $35 per month, depending on locality—average rate of $25 per month used.

Drivers at $80 per month (union scale $3 per day for 3-ton truck).

Depreciation on trucks minus tires, life figured at 75,000 miles for a gasoline truck and 100,000 miles for an electric truck.

Tire cost, based on a guarantee of 8000 miles—6, 6½, 7 and 8 cents per mile for 3, 4, 5 and 6-ton trucks respectively.

Maintenance and repairs based on experiments of Massachusetts Institute of Technology and operating costs of Marshall Field & Company and the Texas Oil Company.

Lubricating oil and grease, 0.005 cent per mile for 3-ton truck.

Gasoline at 13½ cents per gallon in carload lots (quoted price).

Electricity at ½ cent per kilowatt-hour, present cost to the city for night power from Sanitary District.

Operating values, shown in Table 1—taken from actual figures given from fourteen Standard Oil gasoline trucks, more than one hundred Marshall Field & Company electrics and Massachusetts Institute of Technology experimental values.

TABLE 1—OPERATING VALUES FOR GASOLINE AND ELECTRIC TRUCKS

Size of Truck	Miles Per Gallon for Gasoline Cars	Kilowatt-hours Per Mile for Electrics
2-ton	5.00	0.741
3-ton	3.92	0.903
4-ton	3.20	1.064
5-ton	2.70	1.225

Contingencies, covering interest on general operating stores, repair materials, general superintendence, etc., 2 per cent of first cost.

Obsolescence, figured as a fixed charge, it being a factor which decreases the value of the car due to improved methods in the science of construction, 5 per cent.

License, State license only, paid by city —$4 per year for 3-ton truck.

Table 2 shows the estimates for fixed and mileage charges for the two types of truck or tractor when handling a garbage tank of 3-ton capacity.

TABLE 2—FIXED AND MILEAGE CHARGES FOR GASOLINE AND ELECTRIC TRUCKS

	Gasoline	Electric
First cost of three-ton truck or tractor	$4,000	$4,000
Fixed charges per year:		
Interest at 4 per cent	160	160
Garage	300	300
Insurance (fire and liability)	190	183
State license	4	4
Driver	960	960
Obsolescence	200	200
Contingencies	80	80
Total fixed charges per year	$1,894	$1,887
Total per day, 1/300 year	6.31	6.29
Variable expenses per mile:		
Depreciation	$0.0473	$0.0340
Tires	0.0600	0.0600
Maintenance and repairs	0.0300	0.0300
Lubricating oil and grease	0.0050	0.0050
Energy (electricity or gasoline)	0.0344	0.0050
	$0.1767	$0.1340

The costs for hauling with horses (Table 3) are computed on both the present contract price and a possible future price of $6 per day for teams and drivers, and are based on an average rate of travel shown by twenty-three observations on garbage wagons in the city of Chicago. The average rate of travel for garbage wagons loaded is 2.93 miles per hour, and empty 3.11 miles per hour. This value for trucks has been assumed as 10 miles per hour, it being 1 mile per hour less than that recommended as the most economical speed for rated capacity of 3 tons by the National Association of Automobile Manufacturers.

TABLE 3—COSTS FOR HAULING WITH HORSES

Daily Expenses	Teams Costing Per Day	
	$5.50	$6.00
Fixed charges for equipment	$0.021	$0.021
Horses and driver	5.500	6.000
Wagon depreciation, life 22,000 miles	0.084	0.084
Maintenance and repair at 5 per cent	0.021	0.021
Total daily expenses	$5.626	$5.126

In determining the length of haul at which the efficiency of motor trucks begins to increase over the horse-drawn vehicle, it was also necessary to learn about the time of loading and unloading. Experiments showed the average length of time required at the unloading station to be 20 min. and the time required to transfer the tank from the collecting wagon to the truck, 6 min.

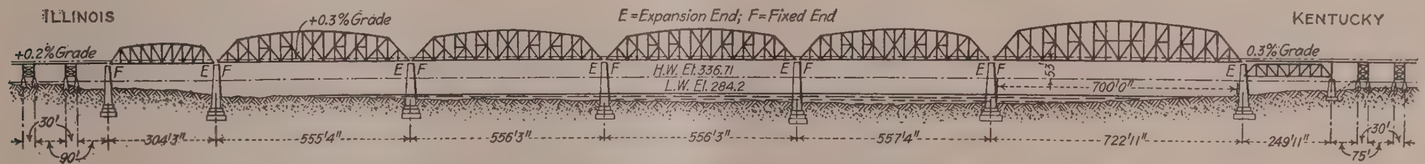
In the diagram presented the curves apply to garbage only, and, as the report states, cannot be used directly for any other kind of haul without corrections covering loading and unloading time. Applying figures taken from the curves shown to the hauling of garbage in the different wards of the city with the different quantities hauled different distances, as worked out for the budget report, there is a saving of but $5,950 per year under present contracts of $5.50 per day for teams, or $15,775 if $6 per day is paid. The figures are based on 8-hr. days. The actual value to the city of working teams on this basis would mean a considerable saving, because at present the working period has been found to vary from less than 6 to 8 hr. per day.

The lack of advantage of the truck service is due, in a great measure, to the fact that one truck-load of garbage has been taken as the unit of handling garbage, although if it were possible for the trucks to haul two tanks at a time the economy over the horse-drawn vehicle would be very apparent.

Longest Simple Truss Span in World to Be Erected Over Ohio River at Metropolis

Bridge to Contain Trusses Built of Silicon-Steel Main Members and Nickel-Steel Eyebars—Steelwork in Crossing More Than One Mile Long

SILICON-STEEL main members and nickel-steel eyebars were adopted for the main truss spans of the new bridge to be constructed over the Ohio River at Metropolis, Ill., by the Paducah & Illinois Railroad, a subsidiary of the Chicago, Burlington & Quincy Railroad. This structure will contain the longest simple truss span in the world—about 720 ft. center to center of end pins. The total length of the steelwork will be more than one mile and the total cost is estimated at about $3,500,000. The bridge is to be a double-track structure designed for unusually heavy live loading—Cooper's E90 engines followed by 7500 lb. per foot of track. For the design of the trusses, however, both tracks are not assumed to be loaded with engines, as is customary, but only the uniform loading is specified for the far track. Rather unusual specifications for impact have been used, the impact factor being independent of the loaded length. The physical and chemical requirements for the special steels will be given.



PADUCAH & ILLINOIS RAILROAD BRIDGE TO BE ERECTED OVER OHIO RIVER AT METROPOLIS, ILL.

GENERAL DIMENSIONS AND SUBSTRUCTURE

The total length of the steelwork in the new structure will be about 5487 ft., consisting of the six through-truss spans and one deck-truss span shown on the accompanying elevation, and viaduct approaches on each side in which fifteen 30-ft. towers supporting girders of various lengths from 62 ft. to 90½ ft. will be used. The floor of these approaches will be of the solid ballasted type, constructed on 0.2 and 0.3 per cent grades as shown, while the main truss floors are of the usual open deck construction. The underclearance required above high water is 53 ft. with a 700-ft. maximum clear opening. The maximum span is thus seen to be about 720 ft. long, which will be the longest simple truss span in the world. All the trusses, except those in the shorter spans at each end, are of the through curved-chord pin-connected type with subpanels throughout, using subdiagonals in compression as shown.

The piers are being constructed by the use of pneumatic caissons which vary in size from 47 x 80 ft. for pier 1 near the Illinois shore to 60 x 110 ft. for pier 6 and 60 x 100 ft. for pier 7 at the end of the longest span. The fixed and expansion ends alternate as shown on the elevation, the Illinois end of each span being fixed. Piles are used under the concrete piers on the approaches.

SPECIFIED LOADING AND IMPACT

The dead-load weight of ties, rails, etc., for the floor of the truss spans is assumed at 500 lb. per foot per track. The concrete deck on the approach spans is taken at 3350 lb. per foot per track, including ballast, rails, ties, etc. The specified live load for the approaches consists of two Cooper's E90 engines followed by a uniform live load of 7500 lb. per foot of track. The live load for the design of the main truss members consists of two Cooper's E90 engines followed by 7500 lb. per foot of track for the near track and the uniform load of 7500 lb. per foot for the far track. The floor system, hangers, and subdiagonals are designed for two Cooper's E90 engines on each track.

The impact on the approaches is to be provided for by the addition of 22,500 lb. to each of four drivers on one rail of each track on the engine which will cause the greatest stress. All members in the truss spans are designed for impact of 10 per cent of the live load, except the hangers and subdiagonals and the web members of the 250-ft. and 300-ft. spans. For the latter web members an impact of 20 per cent is required, and for the floor, hangers and subdiagonals 50 per cent of the live load for one track is added for the near track only.

The wind loads for the truss spans are assumed as moving loads at 30 lb. per square foot on the floor and train, taken to cover an area 20 ft. high, and on the area of truss members for two trusses not covered by this 20-ft. height. The top laterals of the through spans and bottom laterals of the deck spans are designed for wind at 50 lb. per square foot on the exposed area of two trusses, treated as a moving load. The viaduct towers are designed for the usual wind pressure and empty-car assumptions. Longitudinal force is assumed at 20 per cent of the live load applied at the top of the rail for one track only.

ALLOWABLE UNIT STRESSES FOR SPECIAL STEELS

The material in the deck plate girders and towers of the approaches is medium steel. In the trusses all main members except the eyebars are to consist of silicon steel, eyebars and pins of nickel steel, and all other material, including all lacing, is to be medium steel. The allowable unit stresses for total dead, live and impact stress are as follows, in pounds per square inch: For tension, or for compression when reduced by Gordon's formula—30,000 for silicon steel, 20,000 for medium carbon steel, and 35,000 for nickel-steel eyebars; shear and bearing on nickel-steel pins—20,000 and 35,000 respectively; bending fiber stress on plates and shapes—30,000 for silicon steel, 20,000 for medium carbon steel and 35,000 for nickel-steel pins.

For wind stresses the medium steel value of 20,000 is raised to 24,000. For members having alternate stress the gross and net sections required for compression and tension stresses respectively have been determined and one-half of the smaller has been added to the larger section; where tension is the governing stress, the net section is used for the above combination, and where compression is the governing stress, the gross section is used. Pin plates are to be proportioned for the sum of both stresses, except where governed by the sections required at pin holes.

PHYSICAL AND CHEMICAL REQUIREMENTS

All steel is to be made by the open-hearth process. As determined by standard test specimens, the silicon steel is to have an ultimate strength between 80,000 and 95,000 lb. per square inch and a yield point of 45,000. Nickel steel must have an ultimate strength between 95,000 and 110,000, with a yield point of 55,000. The usual requirements of from 55,000 to 65,000, with a yield point of 30,000 are given for structural carbon steel. The drop of the beam is to be carefully observed and the yield point thereby determined taken as the elastic limit of these test specimens. Full-size tests of the nickel-steel eyebars must show an ultimate strength of 80,000 minimum and yield point of 48,000 minimum, with a minimum elongation in 18 ft. of 10 per cent, and a reduction of area of 25 per cent. The per cent elongation of silicon-steel specimens must be 1,600,000/ultimate, with special reduction for material more than 1 in. thick. The accompanying table gives the chemical requirements for the special silicon and nckel steels.

CHEMICAL REQUIREMENTS OF SPECIAL STEELS IN PER CENT

	Max. phosphorus		Sulphur, max.	Carbon, max.	Manganese		Silicon, min.	Nickel
	Basic	Acid			Max.	Min.		
Silicon steel.	0.04	0.06	0.05	0.40	1.00	....	0.25	....
Nickel steel.	0.04	0.05	0.04	0.45	0.80	0.50	....	3.25

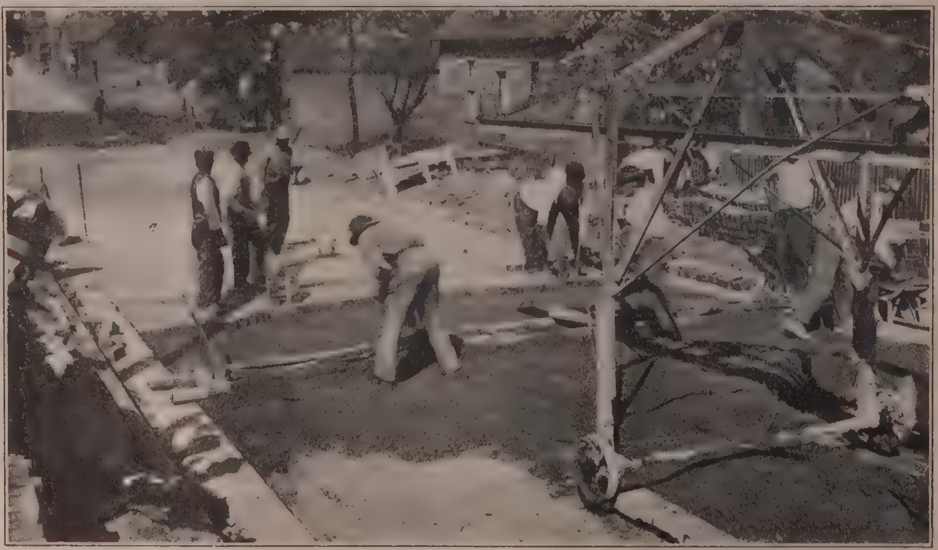
The design and preparation of all drawings, now in progress, are under the supervision of C. H. Cartlidge, chief engineer of the Chicago, Burlington & Quincy Railroad. Ralph Modjeski, Chicago, is the consulting engineer. The total cost is estimated at $3,500,000, and work has been resumed after some months' delay during the stringency in the money market. The contract for the substructure has been let to the Union Bridge & Construction Company of Kansas City, Mo. The superstructure contract went to the American Bridge Company of New York City.

Brick Road Built Monolithic at Paris, Ill.

Paving Blocks Were Laid Directly on Green Concrete Base, Thereby Eliminating Necessity for Sand Cushion

By W. T. BLACKBURN
Consulting Engineer, Dunn Wire-Cut-Lug Brick Company, Paris, Ill.

IT HAS BEEN the writer's experience that the excess of sand cushion has been one of the elements of uncertainty in the construction of a cement-filled brick pavement, and for many years he has made an effort to reduce the depth of this sand cushion to the minimum, realizing that the only function of this bed of sand was to compensate for the irregularities of the surface of the concrete base and the depth of the paving block. Since tile floors and, in a few instances, paving brick have been successfully laid on a rigid base, there would seem to be no reason why country roads should not be more economically constructed by laying the bricks directly on the green mortar base and eliminating the necessity of either a stone or concrete edging. A road recently built at Paris, Ill., was so laid.



DOUBLE TEMPLATE IS HAULED FORWARD BY MIXER OUTFIT

The roadway was first excavated to the proper grade and the sub-grade thoroughly compacted by repeated rolling with a 5-ton self-propelling tandem roller. Steel forms, specially designed for this type of work, of convenient length and 8 in. in depth, were set true to line and grade. The depth of the concrete was 4 in. and the depth of brick the same, making an 8-in. monolithic pavement. Two types of forms have been used, the Heltzel and the Blaw.

LAYING THE BASE

The concrete was mixed in proportions of one part of cement and six parts of the combined aggregate of sand and gravel, in a batch mixer, and spread over the subgrade, to a depth a little over that required by a light wood template resting on the forms.

A steel template, consisting of an I-beam and channel-iron placed 2 ft. apart, supported by rollers carrying the weight of the template on the forms, was drawn over the concrete base, the I-beam cutting the concrete to grade. In between the two members was kept a mixture of dry sand and cement in proportions of 1 to 5, which was mixed dry and deposited in front of the rear member. As the template was drawn forward the concrete base was covered with a thin film of dry sand and cement, filling all of the irregularities of the surface, and leaving a minimum layer of this dry mixture 3/16 in. deep. This mixture immediately took up the moisture from the wet base, leaving an ideal surface upon which to lay the brick.

The steel template referred to is one of the essentials in securing accurate results in this type of construction, and credit is due J. C. Gordon for the development of the template and carrier used. Mr. Gordon is foreman for Allen Jay Parrish, the contractor, and to Mr. Parrish and Mr. Gordon credit is due for working out the details and carrying into successful execution the construction of this type of roadway.

LAYING THE BRICK

The carriers were instructed not to carry in defective brick, and were required to place the brick on the pallets so that when delivered to the setter the brick could be easily laid in the roadway with the best face up and the lugs in one direction. The batting was kept close up to the laying, and, in fact, the pavement was finished, except the grouting, at all times within 25 ft. of the depositing of the concrete base.

Immediately after the brick were laid the surface was rolled with a hand roller 30 in. in length and 24 in. in diameter, filled with water, making it weigh something over 600 lb. I would suggest that this roller should be 30 in. in diameter and made in two sections, giving it additional weight, but still leaving it very easy to operate. This roller seemed to iron out the surface perfectly and gave it the appearance of tile laid on a floor, rather than of a brick surface rolled in the ordinary manner. The brick in no instance were creeled or embedded in the base but were merely made smooth, leaving the joints entirely open. Wire-cut-lug brick were used, leaving perfect separations for the filler.

The filler was applied by an improved method, one part of sand and one part of cement having been mixed dry in a small batch mixer and then conveyed in small quantities to the grout box on the pavement. Sufficient water was added and thoroughly mixed, making the grout of a consistency that would readily flow into the joints after being removed from the box with scoop shovels.

The surface was finally finished with a squeegee, leaving the joints entirely filled and the surface smooth. After the filler had sufficiently set up, the forms were removed.

After sufficient time had elapsed so that there would be no danger of disturbing the pavement with the grading, the side berms were constructed and the earth road graded and thoroughly compacted. The paved portion was a little to one side of the right-of-way, leaving room for a 10-ft. earth road.

A city pavement at Paris, Ill., was constructed in a similar manner, excepting that the gutter was used in place of the side forms, the template riding on the gutter. The base was 6 in. deep.

ADVANTAGES OF NEW TYPE

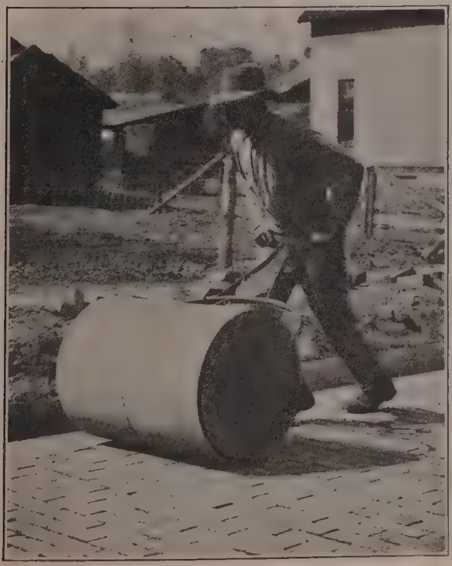
Some of the advantages of the new type may be summarized as follows:

1. By omitting the sand cushion, the construction will not be injured at any time by the interruption of rainstorms, as the pavement, with the exception of the filler, is complete at all times. The filler is never allowed to be left out more than 6 hours after the laying of the brick. However, should storms intervene, no damage would be done by delay if traffic were kept off and the surface kept clean. There is no sand cushion to become saturated, and the worry about rolling the brick surface is eliminated.

2. The certainty of having a 4-in. depth, or the full depth of the block, for the cement filler cannot be ignored.

3. The support of the individual paving block on the rigid base cannot be questioned, as it relieves the condition of suspension where the bricks are solidly cemented together and the sand shrinks away from any portion of the under surface.

4. In the country road especially this type is more easily and cheaply constructed.



SMALL HAND ROLLER BEDS BLOCKS

ON COUNTRY ROAD TEMPLATE RIDES ON SIDE FORMS

5. Every element entering into its construction is positive.

6. A true and uniform surface can be more easily obtained.

7. It eliminates the necessity of the edging, thus reducing the cost of the roadway.

Both the city pavement and the country highway, during the progress of construction, have been examined by many engineers and city and highway officials, and have been pronounced by all a success.

It is my opinion that this type of construction will make a more durable and more economical brick pavement and will provide for the successful use not only of 4-in., but also of 3 and 3½-in. block.

The country highway described was built under the direction of W. W. Marr, State highway engineer of Illinois, and the city pavement referred to was under the direction of C. P. Lycan of Paris, Ill.

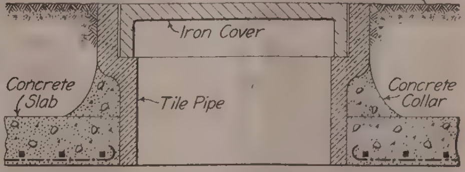
The writer advised the contractor on the work and worked with him personally on perfection of the details, and in certain experiment leading up to the type of pavement here described.

Tile Manholes for Sewage Plants

By H. S. McGEE

Assistant State Sanitary Engineer, Michigan

FOR residential sewage treatment plants and for locations where great depth and structural strength to resist heavy loads are not required, a large vitrified bell and spigot pipe laid bell end up, makes a cheap and satisfactory manhole, a cover being laid in the bell end. Cracked pipe and seconds, provided they are circular and the bell is not seriously injured, are as good as firsts and may be strengthened and held in shape by a concrete collar.



TILE FORMS EFFECTIVE MANHOLE LINING

Forest Service Proposes Grading Rule for Southern Yellow Pine

Density Requirement for No. 1 Grade Is Based on Number of Annual Rings to Inch and Percentage of Summerwood

A SPECIFICATION for Southern yellow-pine timbers, Grade No. 1, has been proposed by the U. S. Forest Service. It follows in the main the recent trend toward a ring specification, which has been discussed in this journal in reference to the rules recommended by a committee of the Yellow Pine Manufacturers' Association on May 5, 1914, and printed in this journal May 23, 1914, page 579. The rule proposed by the Forest Service is as follows:

REQUIREMENTS FOR DENSITY AND RATE OF GROWTH

1. Shall contain only sound wood.

2. Shall show on the cross-section an average of not less than one-third summer wood in timber with six or more annual growth rings to the inch; or one-half summerwood in timber with less than six rings to the inch. The inspection for summerwood and rings shall be made on a radial line from the pith as follows:

I. When the pith is present or can be accurately located.
  (*a*) Radial line of 5 in. present:
    1. Apply inspection over third, fourth and fifth inches from pith.
  (*b*) Radial line of 5 in. not present.
    1. Apply inspection to the second inch on 2 by 3, 2 by 4, 2 by 6, 3 by 3, 3 by 4, 4 by 4 in., or any other dimension material that has less than 16 sq. in. on the cross-section.
    2. In larger material apply inspection to the three inches farthest from the pith.
II. When the pith is not present or can not be accurately located:
  (*a*) When material is over 3 in. thick apply inspection to three inches nearest the pith.
  (*b*) In dimension material 3 in. or less in thickness apply inspection to second inch from the edge nearest the pith.
III. The radial line chosen shall be representative with respect to rate of growth and percentage of summerwood. In case of disagreement between purchaser and seller the figures obtained by averaging the number of annual rings and percentage of summerwood on the two chosen inspection lines shall be used.

3. Contrast in color between summerwood and springwood shall be sharp and the summerwood shall be dark in color.

4. It is sufficient if either end passes the inspection.

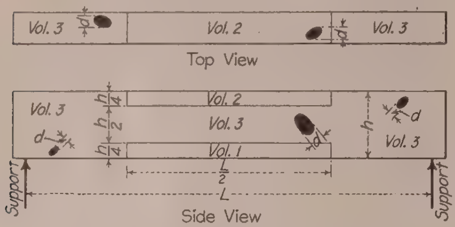
RESTRICTIONS ON KNOTS IN BEAMS

5. Shall not have in Volume 1 (see figure) sound knots with a diameter greater than 1½ in. or one-fourth the width of the face on which they appear—or knots over ½ in. in diameter which are insecurely attached to the surrounding wood. Shall not have in Volume 2 sound knots with a diameter greater than 3 in. or one-half the width of the face on which they appear—or insecurely attached knots with a diameter

greater than 1½ in. or one-fourth the width of the face on which they appear.

The aggregate diameter of all knots within the center half of the length of any face shall not exceed the width of that face.

The diameter of a knot on the narrow or horizontal face of a beam is to be taken as its projection on a line perpendicular to the edge of the timber. On the wide or vertical face, the smallest dimension of a knot is to be taken as its diameter (see figure).



VOLUME RESTRICTIONS FOR DEFECTS

RESTRICTIONS ON KNOTS IN COLUMNS

6. Shall not have sound knots whose diameters are greater than 4 in. or one-third the least width of the column, or knots over ½ in. in diameter which are insecurely attached to the surrounding wood.

The diameter of a knot is to be taken as its projection on a line perpendicular to the edge of the column—as on the narrow edge of a beam (see figure).

RESTRICTIONS ON SHAKES AND CHECKS IN BEAMS

7. Ring-shakes shall not occupy, at either end of a timber, more than one-fourth the width of green material, nor more than one-third the width for seasoned material.

Any combination of checks and shakes which would reduce the strength to a greater extent than the allowable ring-shakes will not be permitted. Shakes shall not show on the faces of either green or seasoned timber.

RESTRICTIONS ON CROSS-GRAIN IN BEAMS

8. Shall not have in Volume 1 diagonal grain with slope greater than one in twenty.

NOTES ON PROPOSED RULES

The Forest Service makes the following explanation of the proposed rules:

1. The greater part of the Southern yellow pine structural timber is now sold under grade classifications adopted by associations of lumber manufacturers. These classifications differ somewhat and are described in rules published by the several associations. The rules here proposed embody the principles which should guide in the selection of high-grade structural timbers. Their use will result in securing timbers of higher average strength and greater uniformity than can be obtained by the use of any of the existing commercial rules. They are intended to apply to structural timbers only and not to material to be used where factors other than strength are of prime importance. In specifying material the advantages connected with the use of commercial grades should be considered and the commercial grades adhered to as long as it is certain that material selected under such rules will meet the requirements.

2. Contrast in the color of summerwood and springwood may be classified as sharp, medium, and poor. Sticks with medium or poor contrast should not be admitted in Grade No. 1 material, except when the proportion of summerwood is considerably in excess of the minimum requirement.

IMPORTANCE OF SHAKES AND CHECKS

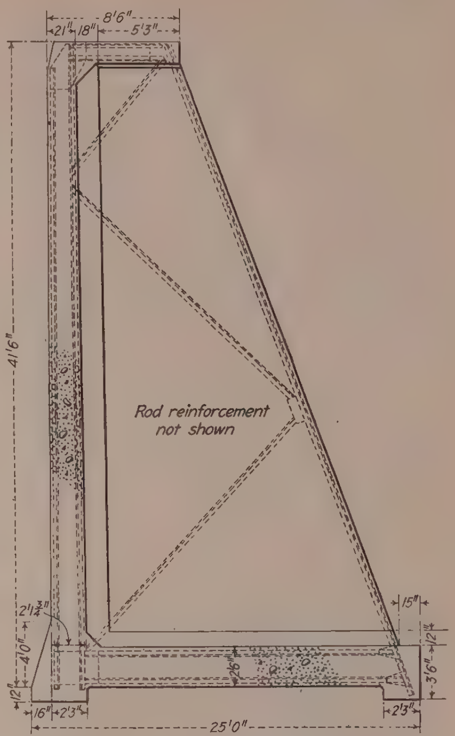
3. The importance of shakes and checks in the middle half of the height of a beam is dependent upon the magnitude of the horizontal shearing stress. The specification given is for beams in which the allowable shearing stress is developed. In beams whose length is more than fifteen times their height the allowable shearing stress is not usually developed and as the ratio of length to height increases, the importance of these shakes and checks decreases proportionately. Ring-shakes showing on an end should be considered as extending to the center. Checks and radial or star-shakes are not usually continuous in the direction of the length of the timber but should not be allowed if, in the judgment of the inspector, their weakening effect is greater than that of the allowable ring-shakes.

Allowable conditions for both green and seasoned material are given because checks are formed and shakes further developed during seasoning. The maximum amount of shakes and checks should not be allowed unless it is practically certain from the appearance of the timber, or from a knowledge of the seasoning conditions, or length of time elapsed since cutting, that it is thoroughly seasoned. For purposes of this rule, it will be considered that at least 1½ months per inch of thickness is required for material to become thoroughly seasoned.

4. In dry interior construction a working stress of 1600 lb. per sq. in. may be used with beams which meet the requirements of the proposed rules.

Light Frames Support Reinforcement for High Retaining Wall

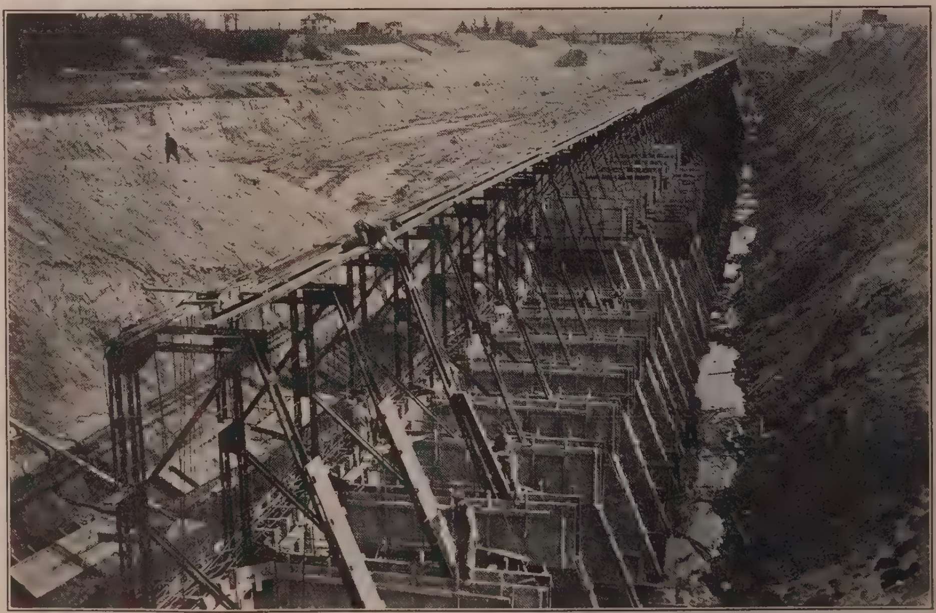
ON the Welland Ship Canal the entrance walls for lock 1, which is nearest Lake Ontario, are 41½ ft. high. In order to support the reinforcing steel, consisting of round rods, light steel frames were designed. Only the angles in the back of the counterfort are counted upon to take any of the stresses in the finished wall. There is a frame in each counterfort. The material for the main members, consisting of uprights in the face of the wall, inclined angles paralleling the back of the counterforts and horizontal members in the base are 3 x 2½ x ¼-in. angles. In the face of the wall and in the base four of these are disposed at the corners of a square and are tied together by gusset plates of ¼-in. material. In the back of the counterfort there are only two of these angles. The gracing running from the angles in the face to those in the counterfort are of 2½ x 2½ x¼-in. material.



RELATION OF FRAMES TO CROSS-SECTION

The angles in the face and in the base are punched for the proper spacing and the horizontal reinforcing bars are placed in the holes. Each frame complete, ready for setting in the wall, weighs 2739 lb.

The work on which these frames are used is under the direction of J. L. Weller, engineer-in-charge, Welland Ship Canal.



STEEL FRAMES SUPPORT RETAINING WALL REINFORCEMENT

Concrete was deposited from cars run on top of frame.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

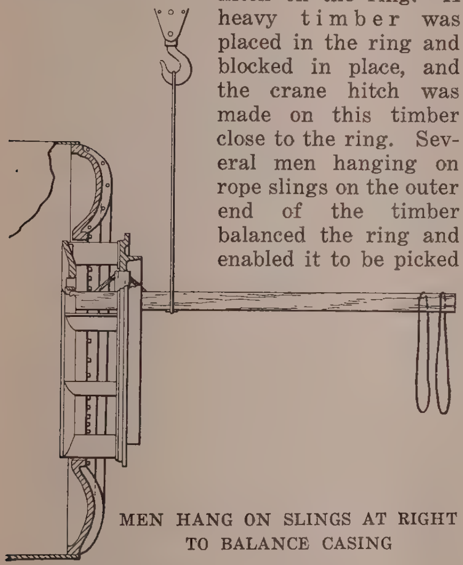
[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Cantilever Timber Raises Ring When Casing Prevents Hitch

By F. M. BIERSACH

Erection Superintendent, Allis-Chalmers Manufacturing Company

THE accompanying drawing shows a method used by the writer in erecting a 6-ton speed ring for a horizontal turbine where the casing prevented making a direct hitch on the ring. A heavy timber was placed in the ring and blocked in place, and the crane hitch was made on this timber close to the ring. Several men hanging on rope slings on the outer end of the timber balanced the ring and enabled it to be picked up level by the crane and inserted in the casing. This occurred on a rush job of overhauling the Malade station of the Beaver River Power Company, near Bliss, Idaho.



MEN HANG ON SLINGS AT RIGHT TO BALANCE CASING

Thirty-Six Inch Water Main Lowered While in Service

WITHOUT shutting off the water a 36-in. main 1000 ft. long, part of the system of Waterbury, Conn., was lowered 6 ft. as part of the program of regrading Thomaston Avenue. The work, as described by R. A. Cairns, city engineer, in his annual report for 1914, consisted of excavating a trench alongside the pipe, cutting away under each length, but leaving earth piers at each joint. Then, while surveyors kept track of the levels, the piers were weakened until the weight of the pipe line caused little settlement. Working up and down the line in this way the pipe gradually came down to the bed blocks, which had been set to the exact elevations.

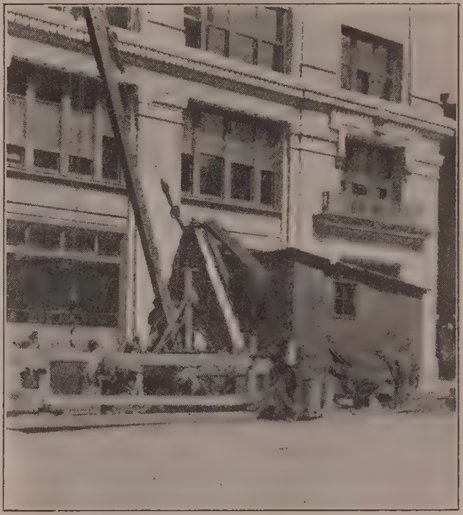
Owing to the pressure of about 100 lb. per square inch on this main and the proximity of two railroad tracks the operation was attended with some risk and required close attention. Under the constant supervision of Charles W. Eddy, assistant engineer, and with John F. Keating, foreman, in charge of the labor, the work went on regularly and systematically and was completed without accident. After driving up the lead joints the line was as tight as ever, according to Mr. Cairns. All material and labor was furnished by the bureau of water.

Steel Support of Decking Gives Large Clear Space for Subway Work

THE SUPPORT of the street decking on Seventh Avenue, on Sections 4 and 5 of Routes 4 and 38 of the new Seventh Avenue subway, New York City, now under construction, has been so designed as to give maximum working space in the trench extending from Greenwich Avenue and West Eleventh Street, the present southerly end of Seventh Avenue, to Thirtieth Street. It has been found especially necessary to devise some scheme for a large working space at headings through solid rock, so that in using maximum safe charge of powder, that is, a charge which will not cause a concussion endangering adjacent buildings, the fragments of rock from the blast do not displace the posts supporting the decking. This problem seems to have been economically solved in the design used.

The method of street support is clearly shown in the accompanying drawing. While the weight of steel required exceeds in value the quantity of timber saved, the advantage of the larger working space permits of more economical methods of shooting and mucking, and a consequent saving in cost of rock excavation. The advantage of economical mucking can be claimed when all earth is encountered. The saving in the cost of handling concrete and final steel erection must also be considered, due to fewer posts, struts and braces to hinder handling and placing of these materials.

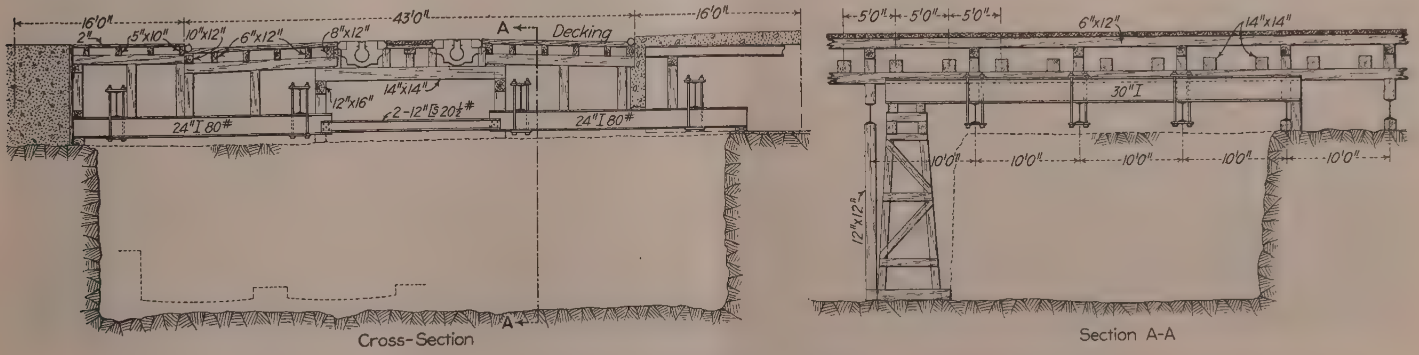
A 24-in. I-beam placed transversely to the street, extends from the net lines of the subway excavation to a little beyond the first rail under the car tracks, on both sides of the street, and two 12-in. channels underneath the car tracks hold the beams together. These beams transfer street loads to four or, at most, six posts to sub-grade, and are about 10 ft. below the street level.



TRAVELER MAKES FIRST EXCAVATION FOR PLACING STEEL HAMMER

In view of the large number of pipes in Seventh Avenue and on account of the fact that rock between Twenty-second and Twenty-fifth Streets is practically found at the street level, much of the pipe being in rock trenches, special permission was granted by the Public Service Commission to do this work by open cut. Even then the closeness of the rock to the pipes required careful blasting to avoid breaking the pipes. A section, taking in half of the avenue and about 30 ft. in length, was opened up and excavated to a depth of about 10 ft. A traveling derrick was used to handle the excavated material and load it on trucks. The 24-in. beams were then placed and the posts carrying decking were set on the beams. The "heading" was thus practically completed and the rock in the "bench" was removed under cover.

This latter process was a simple one. A



Cross-Section

Section A-A

FULL HEIGHT OPEN AT WORKING FACE UNDER DECK SUPPORTED BY NEEDLES, WITH FEW POSTS BEHIND TO BLOCK CUT

30-in. I-beam was used as a needle, was above and supported three of the transverse 24-in. beams. One end of the needle was supported on the bench, a safe distance beyond the top edge, and the other end had a bearing on a timber tower. The transverse beams, underneath the needle beam, were carried by rods, a special type of steel saddle having been designed to transfer load of beams to the rods. This scheme gave a working area from 20 to 30 ft. high and about 30 ft. long. The needles were placed above the transverse beams, so that no extra work in trenching out rock ahead of the excavation was necessary, the transverse beams having been set about 10 ft. deep and below all pipes, as stated above.

On other parts of the Seventh Avenue and on the contractor's Broadway work, Section 2, Routes 4 and 36, where the traveling derrick was not used, the placing of the 24-in. beams was not so easy. The caps, stringers and planking of the decking were first placed, and then a 10-ft. depth "heading" was excavated under cover or mined out from below. Then openings were made in the deck and the 24-in. beams placed.

The United States Realty and Improvement Company is the contractor, for which C. H. Stengel is chief engineer and E. A. Little, general superintendent. F. W. Carpenter and J. H. Meyers are division engineers over Sections 4 and 5 respectively on Seventh Avenue, and the Broadway work is under the office of J. O. Shipman, engineer of the first division. All of this work is under the supervision of the Public Service Commission for the First District, Robert Ridgway, engineer of subway construction.

Trussed Timbers Extend Reach of Cranes at New York Pier

TO SET the first bent of each of six crane and dinky tracks across the site of the Forty-sixth Street pier, New York City, it was necessary to lengthen the booms of the locomotive cranes employed. The timbers used were trussed on top instead of on the bottom, as is the usual practice, with a timber pin-connected boom. This, of course, is the correct rigging, as the boomfall of the crane is attached at a point under the middle of the stick. The sticks are acting as cantilevers, and deflect downward on the outer end under a load. The long outside bents for the first timber tower under each track were framed in halves, which were assembled on top of the cofferdam and set as units by the cranes. The work is being done by the Holbrook, Cabot & Rollins Corporation, for which D. A. Hughes is superintendent.

EXTENDED BOOMS TRUSSED ON TOP

Small Crew Moves 3000 Yards of Dirt in Week with Dynamite

By GEORGE B. SHAFFER
Civil Engineer, Edwardsville, Ill.

A TON of dynamite and seven days time was all that was required to dig a 3400-ft. ditch in Mississippi County, Arkansas. Another ditch 2640 ft. long in the same section in sandy and stumpy soil, was excavated with the same quantity of dynamite in nine days. The grade and shape of these ditches is brought out in the accompanying photographs, taken just after the charges were fired on the second ditch.

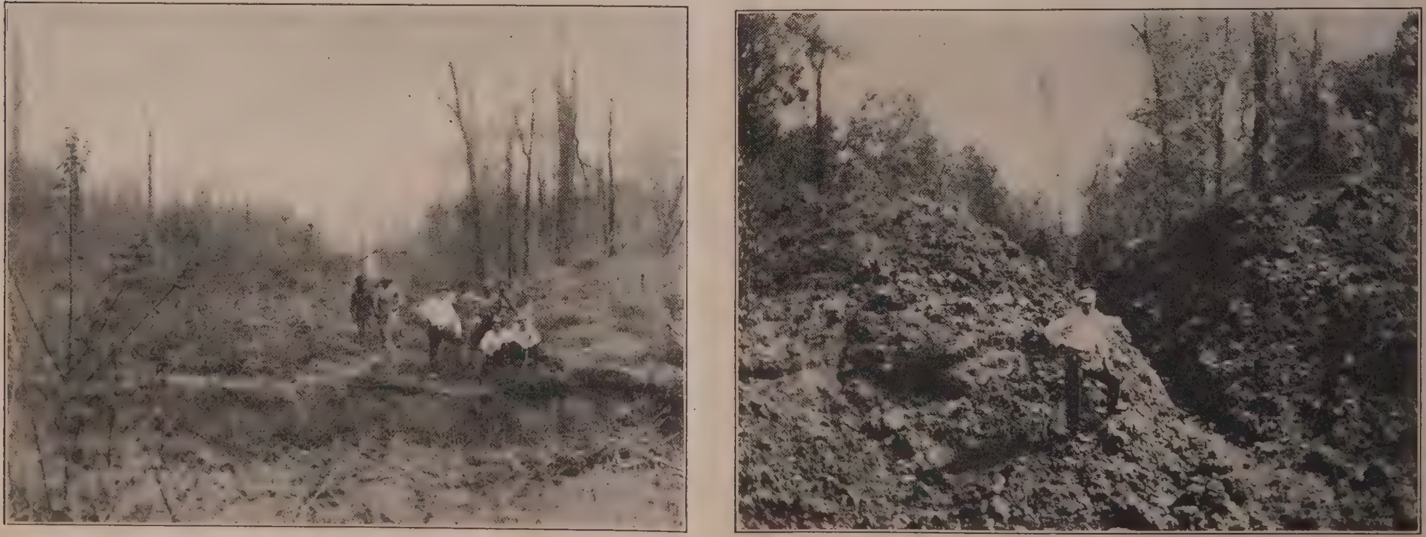
The entire list of tools and materials used on each job comprised a level, a transit, a rod, two axes, five punch bars, stakes, chalk line and 2000 lb. of DuPont 50 per cent dynamite. Stakes were driven along the center line at 25-ft. intervals, and a chalk line at convenient height above the grade of the ditch was stretched on them. The graduated punch bars were used to make holes in the ground every foot to subgrade. The charge in these holes had to be judged by the weight of dirt to be moved, and the nature of the soil. That this can be done accurately is shown by the excellent sections in the photographs. Loose sand and dry soil require heavier charges than compact or saturated ground. Soil containing stumps was, of course, harder to blast than ditch sections in the open. The ditches were each fired in several sections after all preparations were completed.

The first ditch lay along a chain of small swamps, and was from 3 to 5½ ft. deep, and from 5 to 16 ft. wide on top. It emptied into a drainage canal. Water ran the entire length of the ditch without obstruction as soon as the shots were fired. About 200 acres of land were reclaimed by this operation.

The second ditch was dug at the side of the property drained, after a topographical survey of the tract had indicated the advisability of this location. It intercepted a ditch which had no outlet, and traversed much sandy and stumpy soil. It varied in depth from 3 to 7 ft., with a top width of 7 to 16 ft. A good ditch was obtained with the first shot, but sand beds crossed by the ditch absorbed all the flow, so that none reached the mouth of the ditch until the next rains.

The work was done by the writer for Burroughs Brothers, of Edwardsville, Ill.

GRAVEL is about the only hard-surfacing road material Iowa has, and an experimental two-course water-bound road 1¼ miles long of that material will be built this year in Webster County just east of Fort Dodge. The road is for the purpose of testing out the gravel along modern lines to meet hard-surfacing conditions. It is to be a joint affair participated in by the city, county, State Highway Commission and good roads section of the Engineering Experiment Station at Iowa State College. The road will be 16 ft. wide, 8 in. thick in the center and 6 in. at the sides. Frequent tests will insure the proper proportions of gravel and clay binder. A coat of oil will probably be applied one or two months after construction has been completed.


MOUTH OF 2600-FOOT DITCH DUG WITH DYNAMITE IN NINE DAYS, BEFORE AND AFTER FINAL BLAST—TOOLS AND CREW AT LEFT

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Hollow Tile vs. Cinder Concrete Fight in New York Settled

The Board of Aldermen of New York City, on July 6, passed three of the more important articles in the current revision of the building code—article 13 on masonry construction, article 16 on reinforced-concrete construction, and article 17 on fireproof construction, all to take effect three months from date of adoption. These articles were passed with no opposing vote, and finally settle the long-continued deadlock in the Board of Aldermen between the hollow-tile and the cinder-concrete interests. This fight has been waged since 1908, and previous attempts to revise the regulations governing such construction in 1909, 1911 and 1913 met with total failure.

The new articles have been prepared to give all types of construction fair consideration. The success of the present committee of the board was brought about largely through the expert advice and guidance of Rudolph P. Miller, consulting engineer of the committee in reconciling conflicting interests by the method of mutual concession, preliminary hearings and many conferences.

The work of revision of the thirty-one articles of the code under the jurisdiction of this committee is now at least 75 per cent completed, as the revised articles most difficult to pass have now been adopted by the board. In addition to the three articles thus passed, the following have been revised and adopted as part of the new code: Article 2, on materials; article 3, on working stresses and loads; article 4, on classification of buildings; article 5, on restricted areas; article 11, on partitions, fences and walls; article 12, on excavations and foundations; article 14, on wood construction; article 15, on iron and steel construction; and article 29, on plumbing and other systems. The articles which yet remain to be revised are, in general, of minor importance.

Live in Illinois? Structural Engineer? Get Your License

The Illinois structural engineer's license bill, the measure which has been fought so fiercely by the organized architects, was signed July 5 by Governor Dunne. The Attorney General gave his opinion that the bill was constitutional and in good form. There is some uncertainty as to when the bill will become a law and court action is likely. The point to be raised is that, July 1 having passed prior to the executive action, the new law cannot become effective until July 1, 1916. Prominent Chicago engineers are of the opinion that the profession will rapidly adjust itself to the new measure and will aid it to get into working order as vigorously as they worked to have the law passed.

Train Crashes Through Damaged Trestle Killing Three

Three persons were killed and sixteen injured when a Chicago, Milwaukee & St. Paul passenger train from Seattle to Hoquiam crashed through a trestle near Rainier, Wash., July 3, falling down 40 ft. on to a Northern Pacific freight train that was crossing underneath. Investigation disclosed the fact that a bent had been ripped out of the structure by the steel arm of a crane that was being carried on one of the freight cars, which had become loose and, swinging about, had caught one of the diagonal cross-stringers of the trestle.

Hydraulic Appropriation Measures Vetoed in Pennsylvania

The Governor of Pennsylvania, believing that the State treasury would be unequal to the demands, has vetoed a great number of appropriation bills, among them two bills for water survey projects. He also reduced the appropriation for stream gaging work to $10,000, thus practically putting a stop to the great work which the Commonwealth has had in hand. As a result of previous appropriations, however, a very elaborate report on the water resources of the State, running to 1500 pages, quarto size, is now in the hands of the State printer.

The Governor also vetoed a measure which would have appropriated $300,000 per year for five years, beginning in 1917, for the Pymatuning Reservoir project, a matter previously discussed in this journal. An appropriation of $65,000 for this project, left over from a previous $100,000 appropriation, however, was allowed to remain.

General Goethals Has Made No Plans for Future

Press reports that Major-Gen. George W. Goethals had made arrangements to take up a general engineering and construction practice in conjunction with his son, Capt. George R. Goethals, S. B. Williamson, at present chief of construction of the U. S. Reclamation Service, and C. A. McIlvaine, upon his retirement from the U. S. Army, have aroused considerable interest among the engineering profession. The Engineering Record learns by cable from General Goethals that he has made no plans for the future.

Hydraulic Engineers of Pennsylvania Commission Lose Positions

Owing to lack of appropriation the engineering employees of one department of the Water Supply Commission of Pennsylvania will be dispensed with during July. They include division and assistant engineers, field and office assistants, at salaries from $75 to $250 per month. Their experience covers waterworks, water power development, flood investigation, river improvement and hydrography. Farley Gannett, the commission's chief engineer, is endeavoring to find positions, outside of the State service, for those members of his staff who are to be dropped.

Urge Adoption of Metric System

The Spokane, Wash., Engineering and Technical Association on June 11 appointed a committee to place a request with federal officials and congressmen that they co-operate with the United States bureau of standards in the urging the adoption of the metric system as the standard of measurements throughout the United States.

Date Set for New York's Street Cleaning Exhibit

The New York Department of Street Cleaning will hold its second annual exhibition of street cleaning apparatus and appliances in the First Regiment Field Artillery armory, Sixty-eighth Street and Broadway, during the week beginning Monday, Oct. 11. Its object is to awaken public interest to the importance of this feature of city work and to exhibit the latest machinery and appliances in this field. Commissioner John T. Fetherston will have general charge of the arrangements.

Committees Will Study Many Phases of Engineering Education

The annual convention of the Society for the Promotion of Engineering Education at Ames, Iowa, was notable for the large number of representatives who attended from distant parts of the country. The location proved to be exceptionally attractive and the facilities and courtesies extended by the Iowa State College were everything that could be desired. The general characteristic of the convention was the presentation by committees and individuals of new ideas in methods of teaching. The convention devoted itself more to methods than to material and to the characteristics of the students rather than to text books. Of especial interest was the report of the joint committee on engineering education by Dean Anthony.

Detailed discussion of the work to date followed the report of the committee on committees appointed at the Princeton meeting in 1914. This committee divided the work of the society into twenty groups. The work for each committee was outlined and specific tasks were assigned each committee for the ensuing year. Some of their duties are: Administration committee—occupation of engineering teachers during the summer vacation; mathematics committee—to what extent does co-ordination exist among mathematics, physics and mechanics; English committee—present status of the teaching of English to engineering students; mechanics and hydraulics committee—experiments made in methods of teaching mechanics and means used to test these experiments; committee on statistics—record of attendance and mortality of students, location and occupation of alumni kept by each institution and other work along the line of statistical studies being made at institutions; nomenclature committee—recommendations regarding the use of symbols in mechanics and hydraulics. It is expected that this method of making definite assignments will result in much valuable data.

The enthusiasm of the institutional delegates was notable. It became evident that through the institutional delegates the results obtained by the society will be made more available for the different educational institutions.

The following officers were elected: President, H. S. Jacoby, Cornell University; vice-president and chairman of committee on institution delegates, D. R. Chatburn, University of Nebraska; vice-president and chairman of committee on administration, F. H. Constant, Princeton University; secretary, F. L. Bishop, University of Pittsburgh; assistant secretary, L. H. Harris, University of Pittsburgh, and treasurer, W. O. Wiley.

Special Train Will Carry Delegates to Pan-American Road Congress

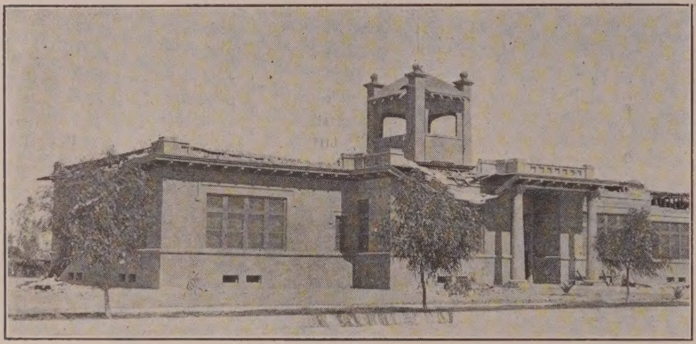
The executive committee of the Pan-American Road Congress, at a meeting held in New York City, June 7, decided to run a special train to Oakland, Cal., to accommodate the delegates who proposed to attend the meeting durig the week of Sept. 13. The route will be selected so as to afford the delegates an opportunity of inspecting road work at the principal cities across the continent.

The executive committee of the Congress will appoint local representatives or chairmen in all the principal cities in the United States and Canada. Each local representative will look after the interests of delegates from his section and help to arouse interest in the meeting.

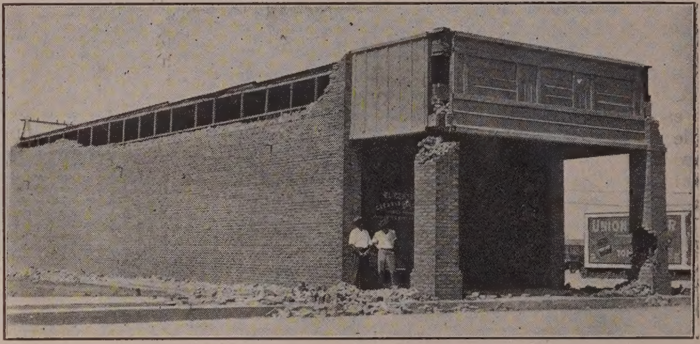
Reinforced-Concrete Stood Up Well in Imperial Valley Quake

Further reports from El Centro indicate that reinforced-concrete stood the test in several instances during the earthquake in Imperial Valley, Cal., June 22 and 23, which was described in this journal, July 3. Light buildings of wooden frames with galvanized-iron roofs and sides, with the exception of one warehouse building, also did well. Over half of the taller chimneys, of brick, tile and cement blocks, gave way. Brick buildings laid with cement mortar held together in nearly all instances, while the walls of tile buildings were partially demolished. Frame buildings were moved from their foundations, which were of tile or brick and to which they were not well anchored. In very few instances were they damaged otherwise.

Brick buildings, with the exception of those anchored, failed, in most instances, at the roof line. One moved out of plumb an inch on both walls, about 3 ft. above the foundation and running the full length of the structure. Another, built about a year ago, had a wall move out 6 in. at one corner for a short distance above the foundation, but the wall held together very well. Columns failed usually about 4 ft. from the base and some broke near the top. Walls that failed were mostly on the east and west sides. The Fifth Street Grammar School in El Centro, constructed of red brick and covered with cement plaster in 1914 was badly damaged, the walls on the north and west face showing diagonal cracks both ways, opening more than half an inch. The concrete columns at the entrance are apparently intact.



GRAMMAR SCHOOL WALLS CRACKED IN MANY DIRECTIONS



BRICK BUILDINGS FAILED IN MOST CASES AT ROOF LINE

Inspection Trips Planned for International Engineering Congress

In order to afford the members of the International Engineering Congress, to be held at San Francisco Sept. 16 to 25, an opportunity of viewing the important engineering works of the West, a number of excursions have been arranged. The annual convention of the American Society of Civil Engineers is scheduled for Sept. 16 and 17, and the intervening days before the International Congress opens will be given over to the following excursions:

1. Sept. 18, the San Francisco high-pressure fire system and the Potrero gas works and electric station A of the Pacific Gas & Electric Company.
2. Sept. 18, Green Valley Waterworks Company on east side of San Francisco Bay.
3. Sept. 19, Spring Valley Waterworks, Storage reservoirs and pumping stations, located on the San Francisco Peninsula.
4. Sept. 19, the Delta lands of the Sacramento and San Joaquin Rivers.
5. Sept. 17 and 18, Great Western Power Company's hydroelectric development on the Feather River and dredging at Oroville.
6. Sept. 18 and 19, Pacific Gas & Electric Company's hydroelectric development at Lake Spaulding and Drum power house at the gold mines at Grand Valley.
7. Sept. 17 to 19, oil fields at Coalinga.

Pennsylvania Companies Will Donate Cement for 12-Mile Concrete Road

The cement industries of Eastern Pennsylvania and public-spirited citizens in Lehigh and Northampton counties have entered into an agreement with the State Highway Department to furnish sufficient cement to build a road twelve miles in length, running from Allentown to Bethlehem and continuing from Bethlehem to Easton. According to the estimates of the State Highway Department, this will require about 40,000 bbl. of cement. Plans are under way also to have these citizens furnish, in addition, the amount of stone which will be necessary to construct this improved highway.

A conference was held in the office of State Highway Commissioner Cunningham, June 14 at which Col. H. E. Trexler, Congressman H. J. Steele, H. R. Fehr, president of the Lehigh Valley Transit Company, G. S. Brown, president of the Alpha Portland Cement Company, William B. Myers, representing the Bethlehem Steel Company and Senator Horace W. Schantz presented the offer of the Associated Cement Companies and the citizens of that district.

The proposition was made that the State Highway Department do the necessary grading and pay the expenses of such engineering changes as might be necessary and build the road. A letter was drawn up to the commissioner pledging the cement industries to furnish 40,000 bbl. of cement, or such part thereof as might be needed for use on the road. Another letter was drawn up pledging the Lehigh Valley Transit Company to furnish $1,000 worth of transportation for the freighting of the cement. Colonel Trexler and the other members of the delegation agreed to take up the project of furnishing the necessary stone and promised to advise Commissioner Cunningham of this at an early date.

San Francisco Wins Hetch Hetchy Construction Point

A party of Congressmen and other representatives of the Government from Washington met San Francisco officials June 17 at the site of the proposed Hetch Hetchy dam to consider the proposed construction plans. In the Congressional party were S. T. Mather, assistant secretary of the interior; A. P. Davis, chief engineer of the U. S. Reclamation Service; Mark Daniels, superintendent of national parks, and James J. Fitzgerald of New York. San Francisco was represented by M. M. O'Shaughnessy, city engineer, and Percy V. Long, city attorney.

The meeting at the site was planned primarily to settle the question of flooding the floor of the valley during construction, to which there is opposition on the part of "nature lovers" who have appealed to Secretary Lane. Mr. O'Shaughnessy proposes to build a temporary diversion dam, which will raise the water on the floor of the valley to a depth of about 30 ft. and submerge between 600 and 700 acres of land. The object of this dam will be to change the course of the Tuolumne River and turn it into a by-pass tunnel about 20 ft. in diameter, on the south side of the stream, so that flood waters may be passed while the excavation is made for the main dam across the river.

In commenting on the results of the conference Representative Borland said, "We came to a substantial agreement that clears the way for the City of San Francisco to go ahead with its work. I am more than ever convinced that San Francisco needs Hetch Hetchy and that no mistake was made when Congress voted the valley into the city's hands. The formation of the lake will not detract from the beauty of the valley, and the erection of the temporary dam will facilitate the work."

National Drainage Congress to Meet at San Francisco

The National Drainage Congress will hold its sixth session in San Francisco Sept. 17 to 21. Under its auspices at the same time there will be held an International Drainage and Flood Control Congress. The object of the congress is to secure the backing of public opinion throughout the country for the enactment of the Clark-Williams bill now pending before the House of Representatives. This bill contains a constructive program looking to the reclamation of 80,000,000 acres of swamp land in the United States, and the establishing of a rational system of flood protection and river regulation throughout the country. Delegates will be sent by various engineering societies, colleges and universities, chambers of commerce, and boards of trade throughout the country.

Department of Labor Inaugurates Many Employment Bureaus

The United States Government, through the Department of Labor, has inaugurated as a part of the Division of Information a country-wide employment bureau. It is the belief of those connected with the work that it will go far toward improving business conditions in the United States. The underlying principle of the work is expressed by the Secretary of Labor in the folowing words:

"The Department of Labor and Docks has established distribution branches throughout the country for the purpose, on the one hand, of developing the welfare of the wage-earners of the United States and improving their opportunities for profitable employment, and, on the other hand, of affording to employers a method whereby they may make application for such help as they need and have their wants supplied through the distribution branches."

Comparative statistics show that there has been in some portions in the United States a surplus of labor, while in other portion a deficiency. It is believed that this condition will be almost eliminated by this work. The United States has been divided into eighteen sections, or "distribution zones," as they are called, and in each of these zones an employment office has been opened. These zones in nearly every case have been subdivided, and branch offices opened under the jurisdiction of the controlling office. This means that a large number of employment offices have been opened by the United States Government. The employer who needs help of any kind can secure what he wants by calling or writing the distribution office in his section. No fee is accepted by the Government from those seeking employment. Every postmaster in the United States is a representative of this employment bureau. At every postoffice in the United States will be found, on application to the Postmaster, blanks for the use of employers in need of help and for the use of persons seeking employment. These blanks, upon being handed to the Postmaster, are transmitted by him, free of charge, to the proper zone office, where both kinds of blanks are properly registered. Proper help is selected for the employer either from applicants residing in the city in which the office is located or from applications on file. A copy of the employer's application is also sent to the Division of Information at Washington, D. C. At frequent intervals these applications are assembled and published in the form of bulletins, and sent to all the distribution offices, thereby making it possible for each office to know where help of any description is in demand. It is the purpose of the bureau to have the best interests of the employer kept in mind by the distribution offices, so that only persons competent to fill the vacant positions of which the department is notified will be recommended.

Illinois to Have State Bureau of Sanitary Engineering

A state bureau of sanitary engineering will be established in Illinois at the earliest possible date, writes C. St. Clair Drake, M. D., secretary and executive officer of the State Board of Health. The new bureau has been made possible as a result of the Governor's signature to the bureau appropriation bill. All positions will be filled through the legal channel, the Civil Service Commission, as soon as the necessary examinations can be held and the successful candidates determined. The position of state sanitary engineer will pay $3,600 for the first two years.

New Edition of Engineer's Book on Yellowstone Park

As a result of his sojourn in 1891 in Yellowstone Park, where, as a member of the Corps of Engineers, U. S. A., he was engaged in the construction of the highway system, Gen. H. M. Chittenden, U. S. A., retired, now of Seattle, Wash., wrote a guide to the park. This was revised in 1903 and now Stewart & Kidd, the Cincinnati publishers, have brought out a revised and enlarged edition. It is a 5½ x 8-in. volume of 350 pages, replete with graphic descriptions of the lore and wonders of the park. The historical section is no less interesting than that which deals with the geologic marvels that have made Yellowstone famous. An interesting chapter is devoted to the road system. The book is of general interest. To those having the good fortune to visit the park it is invaluable.

Personal Notes

E. J. Holland has resigned from the office of city engineer of Guelph, Ont.

Walter W. Kraft has been appointed superintendent of streets of Evanston, Ill.

William R. Holway has been appointed bridge inspector by the Rhode Island Company of Providence, R. I.

Louis J. Larson has been appointed to an engineering position in connection with drainage work at Redwood Falls, Minn.

Samuel J. Mott, civil and sanitary engineer of Saratoga Springs, N. Y., has been appointed city engineer of that city.

W. R. Butler, for the last eighteen years professor of civil engineering in the Royal Military College at Kingston, Ont., has retired from active service.

George A. Reed, formerly city engineer of Barre, Vt., has been appointed city engineer of Montpelier, Vt. He was appointed city engineer of Barre in 1907.

F. L. Brinkman, formerly assistant engineer for the city of St. Thomas, Ont., has been appointed assistant resident engineer in the Department of Public Works at Fort William, Ont.

George M. Rice has been appointed chief engineer of the Puget Sound & Willapa Harbor Railway, succeeding Charles H. Byers, whose resignation is noted elsewhere in these columns.

H. L. Butler, formerly a resident engineer of the State Highway Commission of Illinois, has been appointed instrumentman by the Interstate Commerce Commission, Division of Valuation.

Walter H. Oliver, formerly division engineer for the Atchison, Topeka & Santa Fé Railway at Needles, Cal., has been appointed division engineer for the same company at San Bernardino, Cal.

J. K. Hilton, formerly assistant county engineer of Sac County, Iowa, has resigned from that office to engage in drainage work in Green County, Iowa, under the direction of S. J. Melson.

David Salkind & Company, painting contractors on bridges and structural steel work, of Philadelphia, have moved their offices from Fourth and Market Streets to 151 North Fourth Street.

Capt. James F. Bell, Corps of Engineers, U. S. A., has been promoted to the rank of major to fill the vacancy caused by the death of Maj. A. B. Putnam, which was noted in this journal, June 19.

J. O. James, for the past year holder of the McGraw Fellowship in Civil Engineering at Cornell University and a graduate student in experimental hydraulics at that institution, has been appointed assistant professor of hydraulics at the University of Kansas.

Eugene Couch, formerly engineer of street paving of the city of Houston, Tex., and previous to that, principal assistant city engineer of Dallas, Tex., has been appointed engineer for the Klein Brothers Company, contractors for all kinds of concrete construction, of Dallas, Tex.

F. J. Stimson, formerly engineer of maintenance of way of the Grand Rapids & Indiana Railway, has been appointed superintendent of the Zanesville division of the Pennsylvania Railroad Lines west of Pittsburgh, succeeding Paul Jones, who has been appointed superintendent of the Toledo division.

Frank O. Lee, formerly assistant engineer with F. O. Sinclair, consulting engineer of Burlington, Vt., has been appointed city engineer and superintendent of the water department of Barre, Vt., succeeding George A. Reed, whose appointment to a similar position at Montpelier is noted elsewhere in these columns.

Nathan C. Johnson, consulting concrete engineer, author of the series of articles on the use of the microscope in the study of concrete which appeared in this journal early in the year, and joint author, with Cloyd M. Chapman, of the series on sand testing which appeared recently, has taken offices in the Singer Building, New York City.

F. Le Cocq, formerly assistant engineer in the city engineer's department of Aberdeen, S. D., has been appointed city engineer of that city. He was graduated from Purdue University in 1911 and entered the city service at Aberdeen in 1912. In addition to his duties as city engineer he will have charge of the water and sewer departments.

D. B. Duncan, formerly connected with the L. W. Dumas, Jr., Construction Company, has been appointed superintendent of construction for the W. D. Lewis Company, contractors, of New York City, on a five-story reinforced-concrete warehouse that the company is constructing for the Des Moines & Southern Railway at Fort Dodge, Iowa.

Hurlbut S. Jacoby, formerly chief engineer of the Standard Steel Construction Company of Welland, Ont., whose appointment as instructor in civil engineering at Pennsylvania State College was noted in these columns, April 10, has been retained as associate engineer for summer work by the Samuel Austin & Son Company, industrial engineers and builders, of Cleveland, Ohio.

G. R. G. Conway has resigned as chief engineer of the British Columbia Electric Railway to enter consulting engineering practice in the East. He was honored at an elaborate farewell banquet at the Hotel Vancouver, June 28, tendered by the company, and highly complimented in a cablegram from the board of directors in London, England. He will continue relations with the company as its consulting engineer.

D. D. Howe, formerly an assistant to J. M. Baldwin, consulting engineer, of Atlanta, Ga., has been appointed a transitman with the DuPont Powder Company on the construction of the new plant covering several thousand acres which is being built for manufacture of gun cotton at City Point, Va. The work is a rush job, involving day and night work, and requiring a working force of 12,000 men, located in a town that one year ago had only 450 inhabitants.

Prof. Charles M. Spofford, of the firm of Fay, Spofford & Thorndike, consulting engineers of Boston, and head of the department of civil and sanitary engineering of the Massachusetts Institute of Technology, has been appointed a member of the commission constituted by a recent legislative act to investigate the subject of terminal facilities and the improvement of facilities for the transportation of freight in the Boston Metropolitan District by the Governor of Massachusetts.

John F. Trumbull, formerly chief clerk to the chief engineer of the New York, New Haven & Hartford Railroad, has been appointed chief engineer of the Public Utilities Commission of Connecticut, succeeding C. C. Elwell, who resigned to become a member of the commission. He was graduated from Sheffield Scientific School, Yale University, in 1902, and has engaged continuously since that time in railroad work on the forces of the International Railroad of Mexico, those of the Connecticut Company and the New York, New Haven & Hartford.

Charles H. Byers has resigned from the office of chief engineer of the Puget Sound & Willapa Harbor Railroad to accept an appointment as assistant engineer of the Pacific District of the Interstate Commerce Commission, Division of Valuation, with headquarters at San Francisco. He was graduated from Oskaloosa College in 1881 and was employed on the forces of the Cedar Rapids, Oskaloosa & Southwestern Railway, the Chicago, Burlington & Pacific, the Marion & Manchester and the Burlington & Western from then until 1886, when he was appointed, successively, instrumentman for a private engineering firm, transitman for the Chicago, Milwaukee & St. Paul, and division engineer on the Atchison, Topeka & Santa Fé. Later he entered the service of the Missouri Pacific and remained in it until 1905, attaining the grade of division engineer, maintenance of way. From this service he went to the Chicago, Milwaukee & Puget Sound as district engineer and, from 1909 to 1912, as assistant engineer on special work, did considerable work in connection with railway valuation.

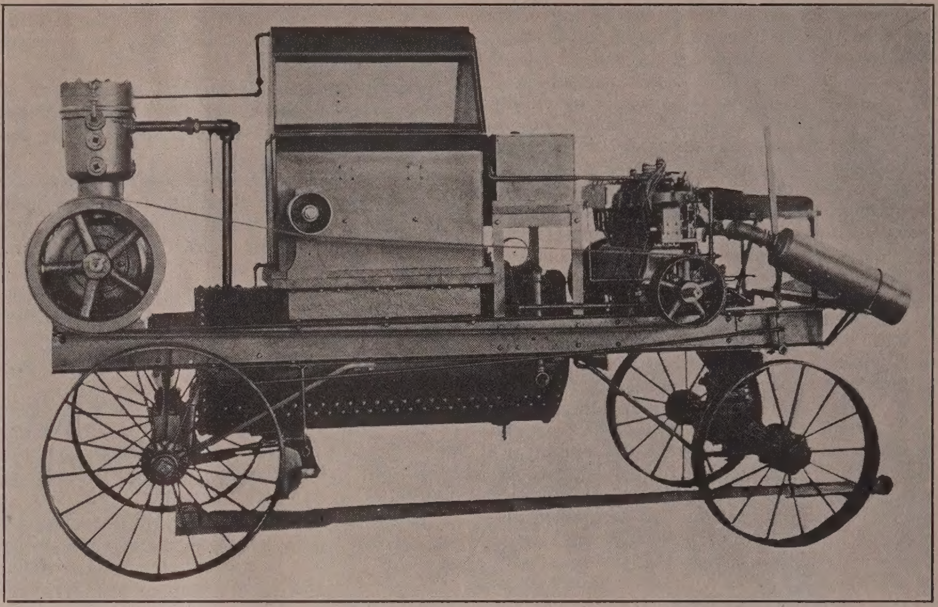
Obituary Note

Leonard D. Croshaw, a Chicago contractor, died at his home in that city July 5.

Light Weight a Feature of Latest Model Air Compressor

Material reduction of weight, due to the use of a four-cylinder, high speed marine engine in place of one of the usual heavy duty single-cylinder type, is a feature of a new model portable air compressor. The machine is said to be particularly adapted for structural steel erection where air is used for pneumatic hammers. It is also designed for the use of contractors when air is necessary for caulking water mains and on jobs where compressed air is used in relatively small quantities.

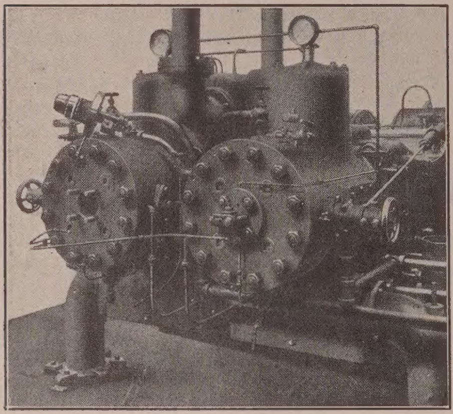
The machine, which is manufactured by the Gardner-Governor Company, Quincy, Ill., is made in 80, 105, 140 and 218 cu. ft. capacities, 125 lb. pressure.



NEW PORTABLE AIR COMPRESSOR USES HIGH SPEED MARINE ENGINE

Compressor Not Needed for Fuel Injection in New Oil Engine

To meet the demand for an oil engine that combines the economy of the Diesel type, yet is not so cumbersome and complicated, the Nordberg Manufacturing Company, of Milwaukee, Wis., is manufacturing a 200-hp., two-cycle engine that makes use of the Diesel principle of ignition, but does not require an air-compressor for injecting the fuel, as this is done mechanically. Other features are the absence of valves and valve gear subjected to pressure, the only valve being a simple piston valve controlling the scavenging air.



OIL ENGINE FOR SMALL PLANTS

Business Notes

The Maher & Byrne Company of Chicago, of which C. L. Anson is president, has been made the Chicago representative of the Kingsford Foundry & Machine Works, manufacturers of heavy centrifugal pumping equipment of Oswego, N. Y.

The Marion Steam Shovel Company and the Marion-Osgood Company of Marion, Ohio, state that the litigation that has been carried on for the past several years by them has been satisfactorily and amicably adjusted. The settlement covers all machinery heretofore shipped by the Marion-Osgood Company and grants it shop rights to continue the use of those patents held by the Marion Steam Shovel Company which are involved in the Marion-Osgood Company's machines as at present constructed.

Trade Publications

J. H. Burnett Iron Works, Inc., Fresno, Cal., and Pittsburgh, Pa. Catalog, 4 x 7 in., 12 pages, illustrated. Describes the patented lock nut, "Johnny Bolt," and illustrates its use and application.

Weber Chimney Company, McCormick Building, Chicago. Catalog, 5 x 9 in., 48 pages, illustrated. Concrete coniform and cylindrical chimneys recently constructed by this organization.

Watson Wagon Company, Canastota, N. Y. Folder, 8 x 11 in., 4 pages, illustrated. A talk on the Watson bottom dump truck, with its special distinctions of front drive and even distribution of load.

Troy Wagon Works Company, Troy, Ohio. Catalog, 5 x 7 in., 30 pages, illustrated. Describes in detail the general features of Troy wagons, then explains each type briefly, illustrating its special use.

Troy Wagon Works Company, Troy, Ohio. Leaflet, four pages, 9 x 12 in. Of interest on account of showing variety of uses of heavy motor trucks—for hauling road materials and in industrial-plant use.

Chicago Pneumatic Tool Company, Fisher Building, Chicago. Bulletin 34-X, 6 x 9 in., 8 pages, illustrated. Relates to class A-G "Giant" gas and gasoline engines, ranging in horsepower from 16 to 130.

Automatic Concrete Mixer Company, Providence, R. I. Catalog, 6 x 9 in., 32 pages, illustrated. Explains the principle on which the Automatic mixer operates and shows pictures of numerous big jobs where it has been used.

Garford Motor Truck Company, Lima, Ohio. Booklet, 6 x 9 in., 16 pages, illustrated. A treatise by S. M. Williams on roads and their influence on economic and social conditions, showing the muddy road, the dirt road and the improved road, and discussing their effect upon the community.

Gemco Manufacturing Company, Milwaukee, Wis. Catalog, 5¾ x 8½ in., 12 pages, illustrated. Deals with appliances and devices for concrete work, such as column and wall clamps, and adjustable joist and beam shores for wooden forms, and a patented wire twister and cutter for tying rod reinforcement.

Armstrong Manufacturing Company, Waterloo, Iowa. Catalog B-I, 7¾ x 10¾ in., 64 pages, illustrated. Covers in detail Armstrong gasoline portable cable-drilling machines designed primarily for drilling blast holes, and adapted especially for quarry requirements, or others where there are large stone or earth displacements.

P. D. Skahen, Syracuse, N. Y. Leaflet, 7¾ x 10¾ in., 8 pages, illustrated. Skahen steel adjustable concrete forms, the special advantages of which, it is claimed, are that they may be adjusted to any length or height, and that they will save much time and labor, as they are constructed simply of steel framework and wall sheets that are attached without any complex devices.

Fairbanks-Morse & Company, Chicago. Catalog, 6 x 9 in., 40 pages, illustrated. Pictures the uses to which Fairbanks-Morse pumping machinery has recently been put for irrigation purposes. Shows types of machinery ranging from a 2-hp. Jack of All Trades engine delivering 350 gal. of water per minute to a 200-hp. multi-cylinder oil engine furnishing power to three pumping stations, the output of which aggregates from 9000 to 12,000 gal. per minute.

National Tube Company, Pittsburgh, Pa., Catalog J, leather, 5 x 8 in., 394 pages, illustrated. An unusually elaborate and expensive book listing and describing the material manufactured at the Kewanee works of the company, including "National" pipe for steam, gas, water and air, cast-iron, malleable iron and brass fittings, "Kewanee" unions and specialties, brass and iron body valves and cocks, radiators and coils, drive well points and well supplies. From cover to cover it is attractive to the eye. The data are presented in clear, compact tables. Almost every heading is illustrated and the illustrations are especially good, particularly those dealing with the "Kewanee" combination brass and iron unions, which are shown in color.

American Sheet & Tin Plate Company, Frick Building, Pittsburgh. Booklet, 10 x 7 in., 32 pages, illustrated. An article by D. M. Buck, metallurgical engineer for this company, discussing the action of corrosion on sheet metal as observed on a series of tests carried on in the Pennsylvania coke regions. The results of Keystone copper bearing steel in comparison with other metal sheeting are given. Tables showing relative losses on exposed test pieces are also included. Catalog, 9¼ x 6¼ in., 32 pages, illustrated. Describes Apollo Best Bloom galvanized sheets and culverts. The illustrations show the product and its adaptation to many uses such as railroad and road culverts, tanks and silos, roofing, warehouses, elevators and other structures that need fireproofing construction. Catalog, 9 x 6 in., 64 pages, illustrated. Provides information relative to formed metal roofing and siding material for buildings, giving in detail descriptions and instructions of the uses to which sheet metal may be put. Booklet, 3½ x 6¼ in., 44 pages, illustrated. Contains a general description of Copper Bearing open hearth steel for roofing tin, and a list of standard sizes of sheeting with prices, weight, size, etc.